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Biosolids Management Alternatives Evaluation
2006 Study Update

Prepared for

City of Reading, PA

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Executive Summary

This Technical Memorandum provides updated facility requirements and costs for the long-term biosolids management options presented in the 2006 Biosolids Alternatives Evaluation report. Three biosolids management plans were considered:

- Alternative 1 - Landfill of Class B biosolids
- Alternative 3 - Land application of heat dried Class A biosolids
- Alternative 4 - Incineration of raw solids

Based on discussions with City staff, Alternative 2 - Land application of Class A biosolids was eliminated from further consideration.

The alternatives were updated to reflect revised projected solids quantities and additional treatment processes not included in the 2006 evaluation. Costs were also updated to reflect 2009 capital costs and expected operations and maintenance (O&M) unit costs. The results of the cost evaluation are presented in ES-1.

Table ES-1. Summary of Biosolids Treatment Costs

Parameter	Alternative 1	Alternative 3	Alternative 4
Capital	$ 41,879,000	$ 62,611,000	$ 57,527,000
Annual O&M	$ 6,141,000	$ 3,994,000	$ 2,760,000
PW of Annual O&M	$ 70,437,000	$ 45,811,000	$ 31,657,000
Total Present Worth[1]	$ 110,558,000	$ 106,305,000	$ 87,700,000
Total Annualized PW Cost	$ 9,639,000	$ 9,268,000	$ 7,646,000

[1]Present worth costs include salvage values

Alternative 4 – Incineration with landfill disposal of dewatered ash is the low cost option based on present worth costs and Alternative 1 – Landfill of Digested and Dewatered Class B Biosolids has the highest present worth costs. The difference in lifecycle costs between Alternative 4 and the second lowest cost option, Alternative 3 - Land application of heat-dried product is 21 percent. The difference in lifecycle costs between Alternative and Alternative 3 is only 4 percent. Cost differences of less than 15 percent are not considered significant at budget level analysis.

Alternative 4 was also the lowest cost option in the 2006 evaluation. The cost differences between the 2006 and the 2009 evaluation are primarily due to the use of conventional digesters in this evaluation compared to egg-shaped digesters that were used to develop costs in 2006, the addition of new PS thickening facilities, new RDTs for WAS thickening and a new building to house the RDTs and centrifuges, which were all excluded from the 2006 study.

The O&M costs of the alternatives were not evaluated to determine their sensitivity to potential fluctuations in electric power and natural gas costs. However, Alternative 3 has greater energy requirements than Alternative 1 and Alternative 4 and would therefore be more susceptible to future energy cost increases. Alternative 1 is more sensitive to disposal costs than the other alternatives; consequently, any increases or decreases in disposal costs will impact Alternative 1 more significantly than the other alternatives.

The non-economic evaluation conducted in 2006, which was developed based on input from City staff, was not revised as part of this study. The ratings of alternatives are presented in Table ES-2.

Table ES-2. Alternative Ratings (2006 Study)

Category	Criteria	Alternative 1 Landfill of Class B Cake	Alternative 3 Heat Drying and Land Application	Alternative 4Incineration and Landfill of Ash
Reliability	Proven Performance	5	5	5
	Simplicity	5	5	4
Impacts on Neighbors	Odor Potential	3	4	4
	Truck Traffic	2	4	5
	Nuisance and Aesthetics	3	4	2
	Public Acceptance	4	5	1
Implementation and O&M	Constructability	4	3	5
	Ease of Permitting	5	5	2
	Ease of Operation & Maintenance	5	4	4
	Impact of Recycle Stream	3	3	4
Sustainability	Capability to Meet Future Regulations	3	5	5
	Impact of Urbanization	3	3	5
	Diversity of Product Outlets	3	5	2
	Good Safety Record	5	3	4
	Green Technology	2	5	3
	MODEL RESULTS	**4.0**	**4.1**	**3.7**

Based on the results of the economic and non-economic evaluation, Alternative 1 - Landfilling of digested and dewatered Class B biosolids is still a viable biosolids management option for the City since the existing federal and state regulations do not mandate solids treatment to Class A standards. Alternative 4 - Incineration with landfill disposal of dewatered ash - has the lowest present worth cost; however, Alternative 3 has the lowest ranking among the alternatives based on the non-economic criteria. The primary concern with incineration is public perception that incinerators produce harmful air emissions. These perceptions and ensuing actions by citizens can result in increasing the time required for permitting activities.

In spite of being the most expensive option, Alternative 3 provides a viable long term biosolids management option for the City. If desired, the process modifications included under Alternative 3 can be implemented in stages to minimize capital outlay. If the project is implemented in a phased approach, modifications to the digestion facility are the recommended first step, to ensure that effective digestion is in place prior to implementing drying.

The modifications to the PS and WAS thickening processes are somewhat independent of the other systems and can therefore be implemented at any point during the project.

Section 1. Introduction

This Technical Memorandum provides updated facility requirements and costs for the long-term biosolids management options presented in the 2006 Biosolids Alternatives Evaluation report. The revisions presented herein are based on updated solids quantities and some modifications to the biosolids treatment processes from the 2006 report.

The Fritz Island WWTP produces Class B biosolids, which are currently dewatered and landfilled. This management program has worked well; however, due to increasing hauling distances to landfills and rising tipping fees, the City was concerned with long term dependence on landfilling. Consequently, the City conducted an evaluation to identify long term biosolids management options in 2006. However, the increase in biosolids quantities since the study has impacted the facility requirements and costs for the biosolids processing options identified in the report. The purpose of this evaluation is to review the facility requirements and sizing from the 2006 study and expand the biosolids treatment and handling facilities as required to treat the increased biosolids quantities.

Section 2. Solids Quantities

The solids quantities for this evaluation were estimated using completely mixed activated sludge (CMAS) models based on the projected raw wastewater characteristics presented in Section 2 of the Preliminary Engineering Report. The raw wastewater characteristics to the WWTP have changed considerably since the 2006 study, resulting in more solids production than the 2006 projections. The revised solids quantities used in this evaluation along with the 2006 quantities are presented in Table 2-1.

Table 2-1 Solids Quantities

	2006 Alternatives Study		2008	
	Maximum Month	Annual Average	Maximum Month	Annual Average
Primary solids, ppd	33,200	28,600	**61,600**	**47,900**
WAS, ppd	32,000	25,800	**42,900**	**34,700**
Total raw solids, ppd	65,200	54,400	**104,500**	**82,600**

Section 3. Description of Alternatives

Four solids processing alternatives were evaluated for the 2006 study, consisting of:

- Alternative 1 - Landfill of Class B biosolids
- Alternative 2 - Land application of Class A biosolids
- Alternative 3 - Land application of heat dried Class A biosolids
- Alternative 4 - Incineration of raw solids

Based on discussions with City staff, Alternative 2 - Land application of Class A biosolids was eliminated from further consideration. Consequently, only three solids processing alternatives evaluated in the 2006 were updated for this report. The alternatives remain similar to those evaluated for the 2006 report; however, based on discussions with City staff during the development of the Preliminary Engineering Report (PER), some processes and equipment were modified. Additional processes that were considered in several Technical Memoranda, including co-digestion with fat, oil and grease (FOG) and gas utilization options, were not included in this update. The PER included separate solids handling for industrial solids generated by Corestack; however, this update has been limited to the equipment and processes supporting the municipal solids and does not include processes for industrial solids. The evaluated alternatives, updated to reflect decisions used for the PER, are briefly described in the following sections.

Alternative 1: Landfilling of Digested and Dewatered Class B Biosolids

This alternative includes thickening, digestion, and centrifuge dewatering. One existing digester will be converted to a gravity thickener for primary solids (PS) thickening. Rotary drum thickeners (RDTs) will be used to thicken waste activated solids (WAS). Thickened PS and thickened WAS (TWAS) will be blended and pumped to conventional digesters for anaerobic digestion. The digested solids will be dewatered using centrifuges operated on a 24 hours per day, 5 days per week schedule. The dewatered cake will be disposed at a landfill.

The biosolids treatment costs in the 2006 study were based on the use of egg-shaped digesters for anaerobic digestion. However, based on subsequent discussions with the City, it was decided to use conventional digesters for developing the design cost opinion. Consequently, the revisions presented in this study are based on the use of conventional digesters.

Figure 3-1 is a schematic illustration of biosolids processing Alternative 1.

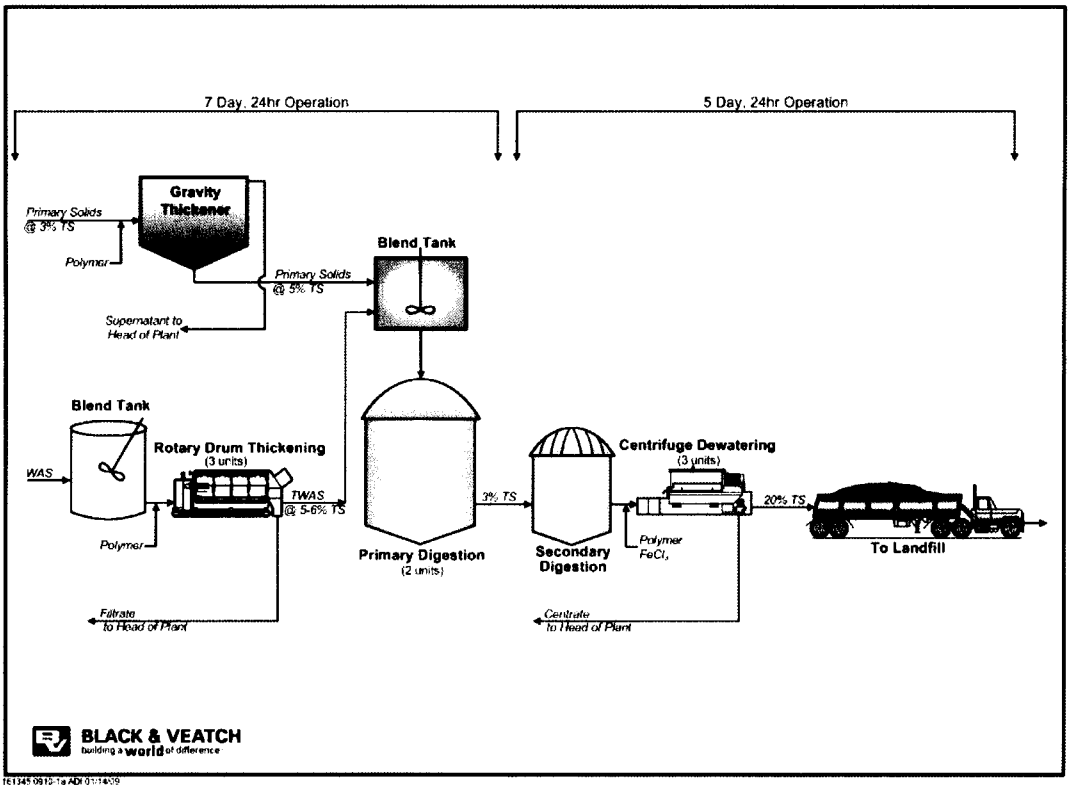


Figure 3-1. Alternative 1 - Landfilling of Digested and Dewatered Class B Biosolids

Alternative 3: Land Application of Heat Dried Class A Biosolids

This alternative is identical to Alternative 1 except for the post-digestion heat drying step. The dewatered solids from the centrifuges will be conveyed to the drying facility using cake pumps. The modular, indirect thermal drying process will produce a granular product that will be transferred to product storage silos using pneumatic blowers. The product storage silos will be equipped with a live bottom that would facilitate loading of the dried product directly into the truck bed.

The drying system is sized to dry all digested municipal solids during a 24 hours per day, 5 days per week drying schedule. Dryers will be stopped for 2 weeks per year for maintenance. The dewatered biosolids will be disposed at a landfill during that time.

The energy requirements for drying will be provided by biogas generated from the anaerobic digestion process. Natural gas will be used to supplement biogas, as needed. For purposes of this evaluation, it was assumed that digester gas would primarily be used for process heating and any surplus gas would be supplied to the dryer. It may be possible to capture heat from the dryer condensate for process heating. The feasibility of using recovered heat for process heating can be further evaluated if this alternative is selected for implementation. The off-gases from the drying system will be treated through a thermal oxidizer for odor control. The energy required by the thermal oxidizer will be provided using natural gas.

Figure 3-2 is a schematic illustration of Alternative 2.

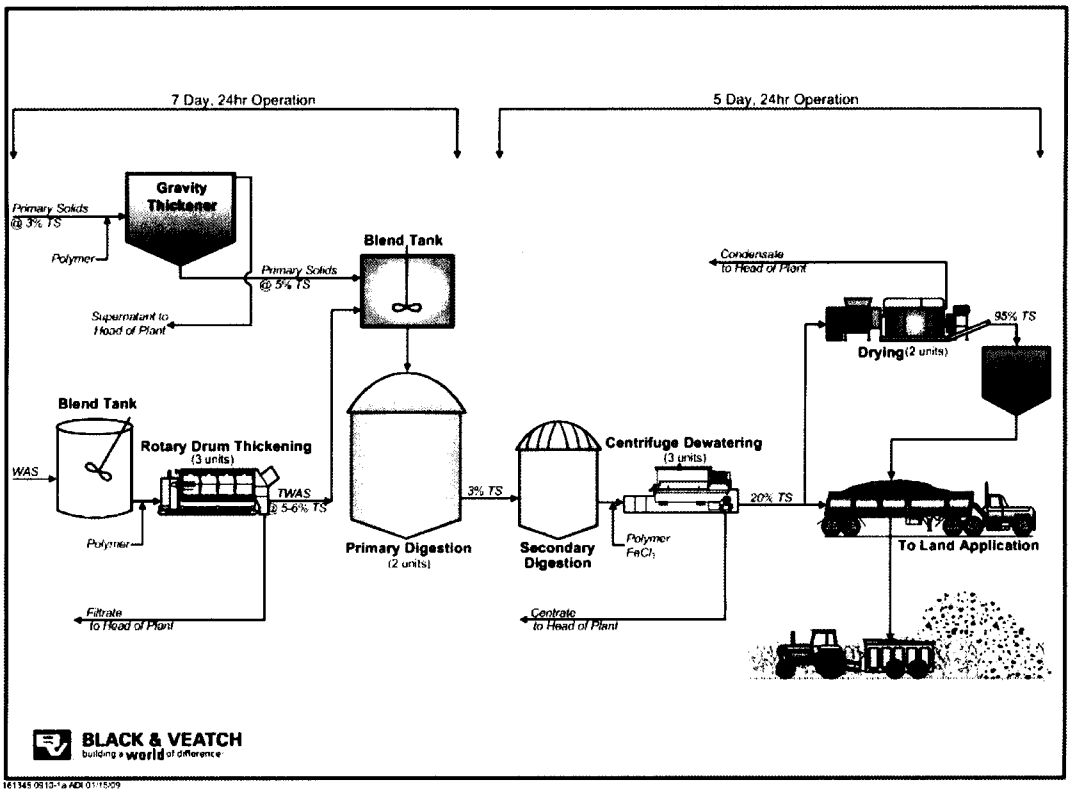


Figure 3-2. Alternative 3 - Land Application of Heat Dried Class A Biosolids

Alternative 4: Incineration with Landfill Disposal of Dewatered Ash

This alternative provides incineration for raw, centrifuge dewatered solids. While digested solids can be successfully incinerated, combustion of raw solids is more energy efficient. Consequently, no anaerobic digestion is included in the incineration option. Eliminating the digestion process also affects the quantity of solids in the centrifuge feed, and therefore, the dewatering loading rates and polymer requirements.

This alternative was developed based on the use of fluid bed incinerators. The incinerator will operate on a continuous 24 hours per day, 7 days per week schedule. The dewatering units will operate in tandem with the incinerators to provide a continuous supply of dewatered cake. The incinerator will be stopped for 2 weeks per year for maintenance. The overall costs for this alternative were developed based on contract lime stabilization and disposal of the lime-stabilized Class B product at a landfill when the incinerator is not in operation.

With heat recovery from exhaust gases by means of a hot windbox, the incineration process is expected to be autogenous at a dewatered solids concentration of at least 26 percent. However, natural gas will be required during initial startup to raise the system temperature to the required operating conditions. Figure 3-3 is a schematic illustration of Alternative 3.

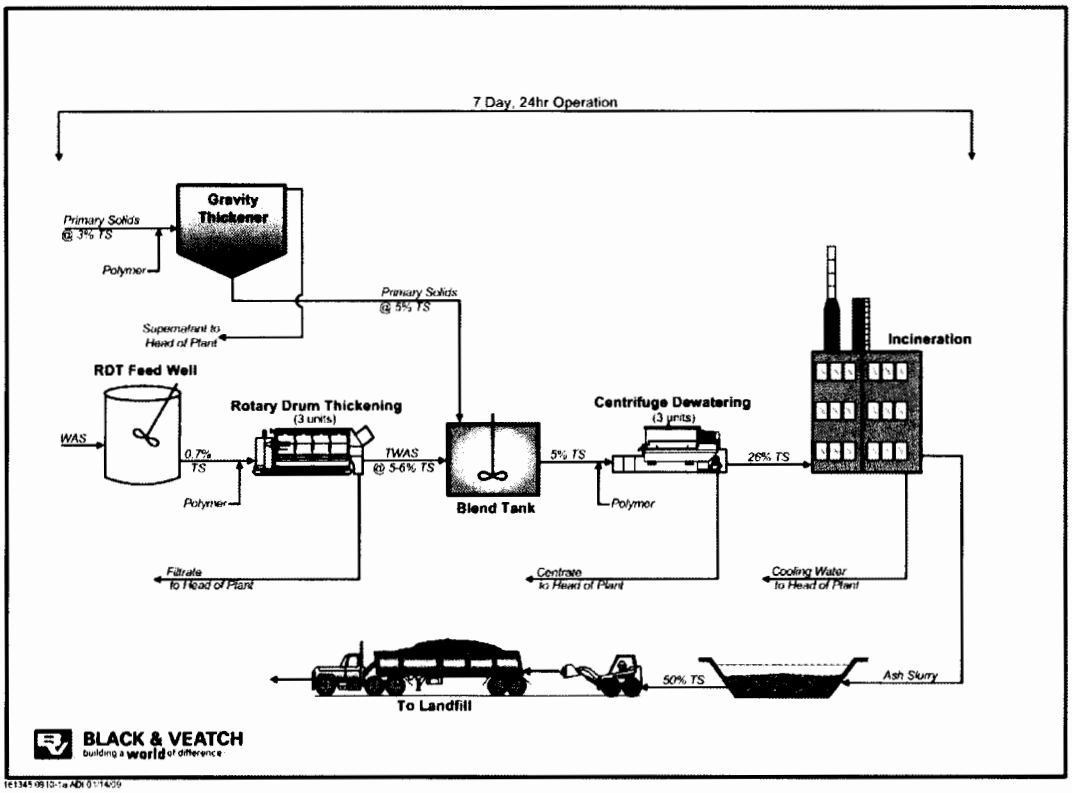


Figure 3-3. Alternative 4 – Incineration with Landfill Disposal of Dewatered Ash

Section 4. Solids Thickening

Each of the biosolids management alternatives considered for the City in this update includes thickening processes for PS and WAS; however, each of these thickening processes is different than what was presented in the 2006 study. The 2006 study did not include a separate gravity thickening step for PS, which has been added during the development of the PER. The 2006 study included WAS thickening, but was based on using the existing gravity belt thickeners (GBTs), and had minimal changes to the existing system. As part of the process improvements developed during the PER, rotary drum thickening (RDTs) replaced the existing GBT system. The primary driver for the process modifications was to increase the solids concentrations of thickened PS and thickened WAS so that capacity requirements for downstream processes could be reduced. The RDTs also provided better containment and collection of foul air from WAS thickening.

The thickening facilities are sized for 24 hours per day, 7 days per week operation. The following sections provide the conceptual design criteria and the facility requirements for PS and WAS thickening.

4.1 Primary Solids Thickening

As described in the PER, the PS from the municipal treatment process will be pumped from the primary clarifiers to a gravity thickener where it will be thickened from approximately 3 percent total solids (TS) to 5 percent TS. Progressing cavity pumps will be used to pump the thickened PS to the anaerobic digester blend tank. Decant from the gravity thickener will flow by gravity to the decant wetwell, from where it will be pumped to the BNR basin splitter box.

An existing primary digester will be converted to a gravity thickener for PS thickening. The conversion will require digester cleaning, removal of existing digester mixing equipment, gas piping, and cover, and installation of new sludge collection equipment, cover, instrumentation and controls, dilution water piping, thickened sludge pumping, and odor collection ducting.

Primary sludge thickening will require the following new facilities and/or modifications to existing facilities:

- Conversion of existing primary digester No. 2 to gravity thickener
- New thickener rake mechanism
- New polymer system
- Two PS feed pumps
- Two thickened PS transfer pumps
- New gravity thickener decant wetwell, 12,000 gal capacity
- Two decant pumps

The conceptual design criteria for the gravity thickener are listed in Table 4-1.

Table 4-1. Gravity Thickener Design Criteria

Parameter	Units	
Operating Schedule	h/d - d/wk	24 - 7
No. of Units		1
Diameter	ft	75
Surface Area	sf	4,418
Primary Solids - Flow Rate		
MM	gpd	246,100
AA	gpd	191,400
Thickener Hydraulic Loading Rate		
MM	gpd/sf	56
AA	gpd/sf	43
Primary Solids - Solids Feed Rate		
MM	ppd	61,600
AA	ppd	47,900
Thickener Solids Loading Rate		
MM	pph/sf	0.6
AA		0.5
Dilution Water Requirements		
Water Source		Utility Water
Flow	gpm	340
Polymer Dosage	lb/dt	1 - 2

4.2 Waste Activated Solids Thickening

As described in the PER, the WAS will be pumped from the final clarifiers to new blend tank at the Solids Handling Building, where it will be mixed to provide a consistent feed to the RDTs. Three 300 gpm RDTs will be provided for WAS thickening. Two units will provide the firm capacity needed at maximum month conditions and the third will be a redundant unit. Thickened WAS will flow by gravity to a thickened WAS wetwell and the filtrate will be directed to a filtrate wetwell.

WAS thickening will require the following new facilities and/or modifications to existing facilities:

- Three (2 duty, 1 spare) 300 gpm capacity RDTs
- Thickening feed well with mixer, 62,000 gal capacity for 2-hour detention
- Three WAS feed pumps
- Three thickened WAS pumps
- Filtrate well, 15,000 gal capacity for 30-minute detention
- Three filtrate pumps
- New polymer system

The conceptual design criteria for the WAS thickening equipment are listed in Table 4-2.

Table 4-2. WAS Thickening Equipment Design Criteria

Parameter	Units	Criteria
RDTs		
Operating Schedule	h/d - d/wk	24 - 7
Number of Units		3 (2 duty, 1 spare)
Rated Capacity, each	gpm	300
Thickened Solids	% TS	5-6
Solids Throughput Capacity	lb/hr	880@0.7%Feed
Waste Activated Solids - Flow Rate		
MM	gpd	735,000
AA	gpd	539,900
Total Flow Rate of Solids		
MM	gpm/duty machine	255
AA	gpm/duty machine	206
Waste Activated Solids – Solids Feed Rate		
MM	gpd	42,900
AA	gpd	34,700
Total Flow Rate of Solids		
MM	pph/duty machine	894
AA	pph/duty machine	723
Wash Water Requirements		
Water Source		Utility Water
Flow	gpm/duty machine	18-22

Average Polymer Dosage	lb/dt	5 - 15

The costs for the PS and WAS thickening facilities are included with the biosolids management alternatives under Section 6 - Economic Evaluation.

Section 5. Conceptual Design Criteria for Biosolids Treatment Alternatives

The conceptual design criteria for the biosolids management alternatives are summarized in the following sections.

5.1 Alternative 1 - Landfilling of Digested and Dewatered Class B Biosolids

Alternative 1 includes anaerobic digestion of thickened PS and thickened WAS, dewatering of anaerobically digested biosolids, and landfilling of dewatered solids. Detailed descriptions of the Alternative 1 unit processes for thickening, digestion, and dewatering are presented in the PER.

This alternative will include the following new equipment and facilities for digestion and dewatering in addition to the PS and WAS thickening facilities discussed under Section 4.0 – Solids Thickening.

Anaerobic Digestion Facility

- New digester feed blend tank with mixing, 42,000 gal capacity for 4-hour detention
- Three digester feed pumps
- Two conventional digesters, 1.92 million gallon (MG) capacity each
- Ancillary equipment, including digester mixing, heat exchangers, boilers, etc.
- New digester control building
- New mixed secondary storage tank, 1.92 MG capacity with membrane cover for gas storage
- Chemical feed system for struvite control
- Gas collection and handling system
- Waste gas flare

Dewatering Facility

- 23,240 square feet 2-story thickening/dewatering building
- Three dewatering centrifuges
- Three centrifuge feed pumps

- New polymer system
- Three reversing conveyors
- Three dewatered cake pumps
- New centrate well, 9,000 gal capacity for 30-minute detention
- Two centrate pumps
- New centrate EQ basin with mixing
- Two centrate return pumps

The conceptual design criteria for the anaerobic digestion and dewatering facilities are listed in Table 5-1.

Table 5-1. Digestion and Dewatering Design Criteria

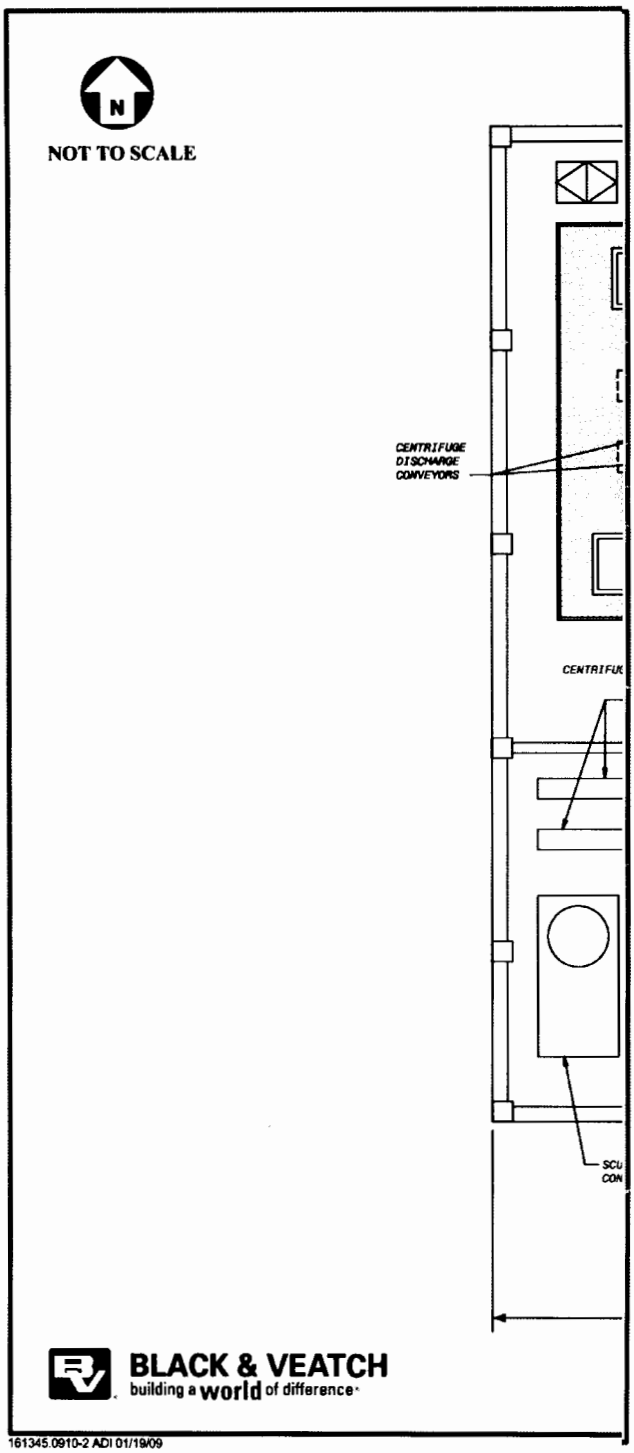
Parameter	Units	Criteria
Anaerobic Digestion		
Operating Schedule	h/d - d/wk	24 - 7
Digester Feed Flow		
MM	gpd	250,500
AA	gpd	198,000
Digester Feed Solids		
MM	ppd	65 , 500
AA	ppd	51,800
Unit Volume	MG	1.92
Total Volume	MG	3.84
SRT at MM	days	15
Cover		Fixed- Steel
Type of Mixing		Pumped
Type of Heat Exchangers		Tube-in-Tube
Expected VS Reduction	%	45
Digester Gas Production	scf/lb VSR	16
MM	scfd	624,000
AA	scfd	492,000
Digested Solids Flow		
MM	gpd	250,500
AA	gpd	198,000
Digested Solids		
MM	ppd	65,500
AA	ppd	51,800
Storage Tank		

Number		1
Unit Volume	MG	1.92
Total Volume	MG	1.92
Cover Type		Membrane Gas Holder

Table 5-1. Digestion and Dewatering Design Criteria (Cont'd)

Parameter	Units	Criteria
Centrifuge Dewatering		
Operating Schedule	h/d - d/wk	24 - 5
Number of Units		3 (2 duty, 1 spare)
Digested Solids - Flow		
MM (7-day basis)	gpd	250,500
AA (7-day basis)	gpd	198,000
Hydraulic Loading Rate		
MM (5-day basis)	gpm/duty machine	122
AA (5-day basis)	gpm/duty machine	96
Digested Solids		
MM	ppd	65,500
AA	ppd	51,800
Solids Loading Rate		
MM (5-day basis)	pph/machine	1,910
AA (5-day basis)	pph/machine	1,511
Polymer Dosage	lb/dt	18 - 22
	gal	5,300
Dewatered Solids	% TS	20-25
Dewatered Cake Pump	gpm	38

The solids handling building will house the WAS thickening and the centrifuge dewatering equipment. The building will be a two-story structure with thickening and dewatering equipment on the upper level and the associated wetwells and pumps on the lower level. Polymer feed tanks and feed pumps will be located adjacent to the thickening and dewatering equipment on the second floor. Polymer storage, mixing/aging tanks, and polymer solution transfer pumps will be located on the first floor. The upper and lower level plans of the thickening and dewatering building are shown by Figure 5-1 and Figure 5-2, respectively.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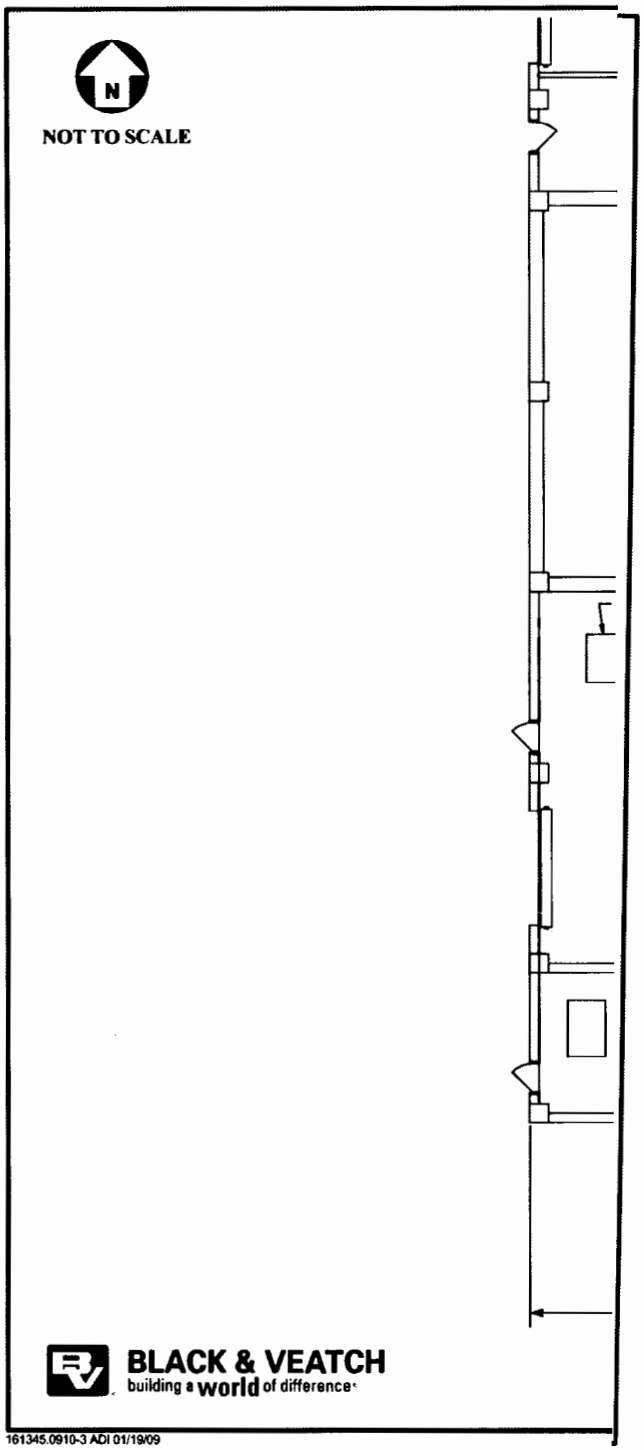
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5.2 Alternative 3 – Land Application of Heat-Dried Product

This alternative is identical to Alternative 1 except for the post-digestion heat drying step. The dewatered solids will be transferred from the centrifuges to the dryer feed hoppers using cake pumps. The costs for this alternative were developed based on using Komline-Sanderson's paddle dryers for biosolids drying. The dried product will be transferred from the dryers to elevated product storage silos for short-term storage. A detailed description of the Alternative 2 processes is presented in the PER.

Figure 5-3 shows the typical configuration of a paddle dryer system.

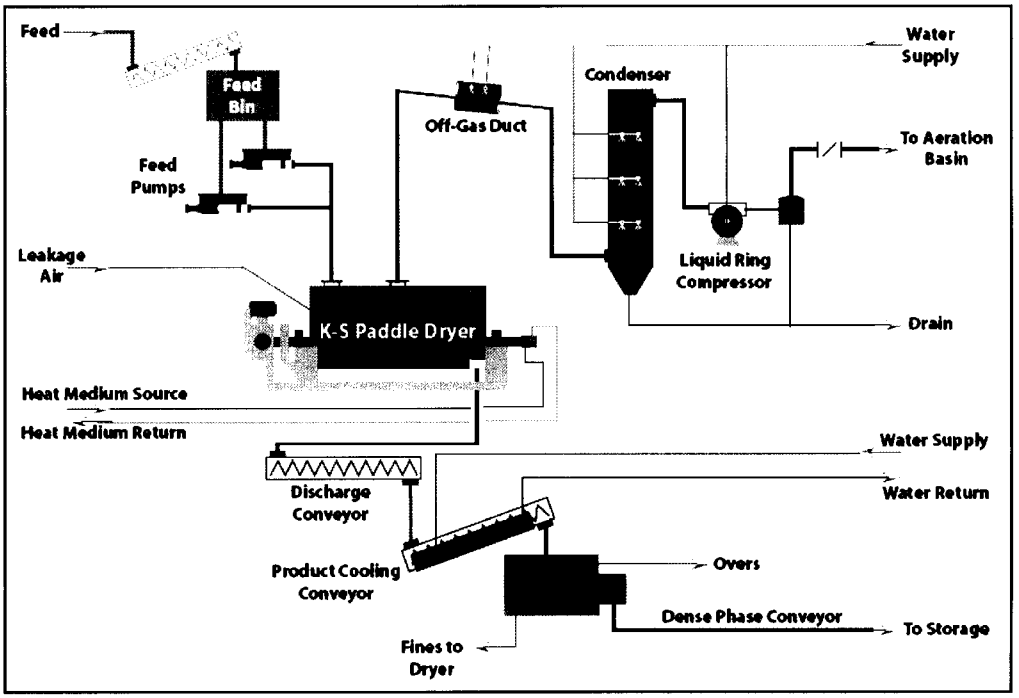


Figure 5-3. Komline-Sanderson Paddle Dryer System
(Courtesy of Komline)

In addition to the thickening (Section 4), anaerobic digestion (Section 5.1), and dewatering (Section 5.1) facilities discussed for Alternative 1, this alternative will require the following new facilities for thermal drying.

Thermal Drying

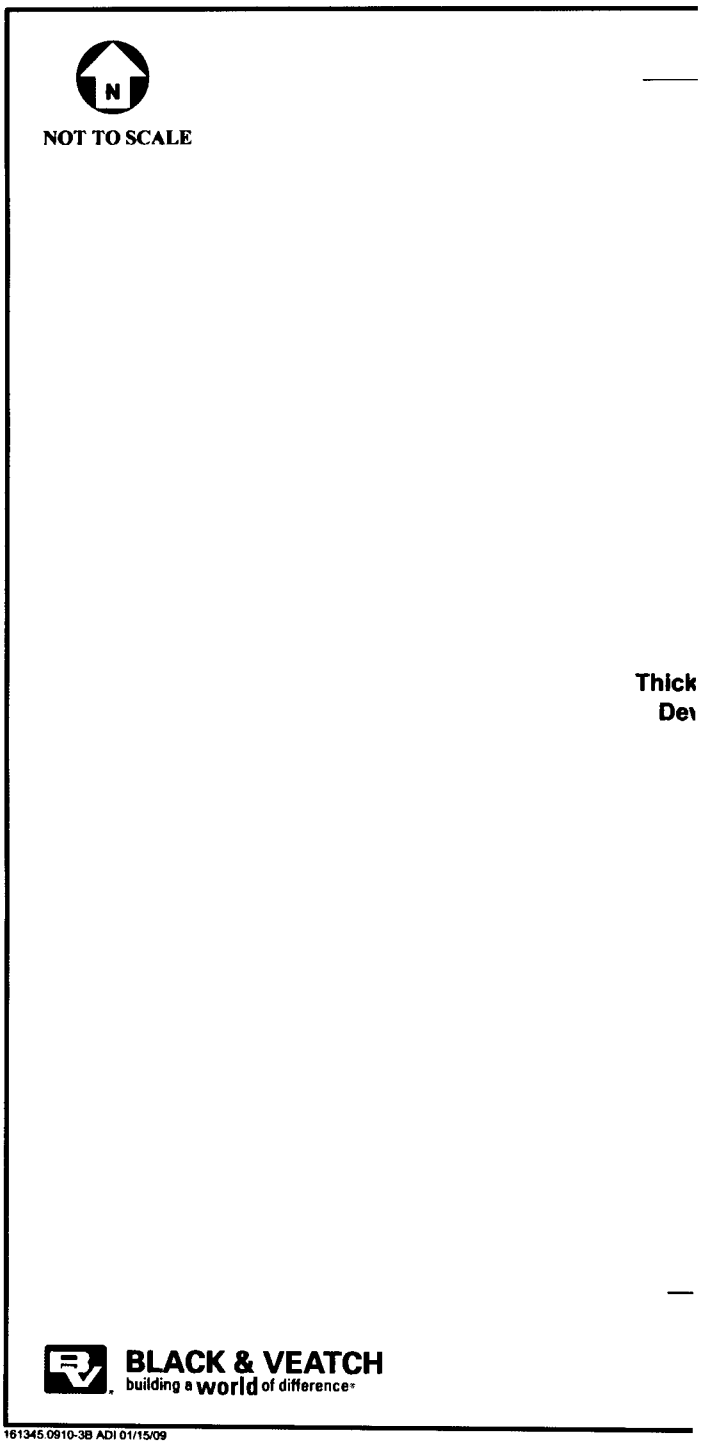
- 8,960 square feet drying building
- Two dewatered cake feed pumps
- Two new thermal dryers with product cooling and screening
- Two thermal oxidizers for odor control
- Two storage silos

The conceptual design criteria for the dryer facility are listed in Table 5-2.

Table 5-2. Dryer System Design Criteria

Parameter	Units	2008
Dryer System		
Operating Schedule	h/d - d/wk	24 - 5
Number of Units		2
Equipment Type		Indirect Paddle Dryers
Fuel Type		Digester and Natural Gas
Dewatered Solids		
MM (7-day basis)	ppd	65,500
AA (7-day basis)	ppd	51,800
Dewatered Cake to Dryer, TS	%	20-25
Dried Product TS	%	92 to 95
Evaporative Capacity Required		
MM (5-day basis)	pph H_2O	15,000
AA (5-day basis)	pph H_2O	11,900
Energy Requirement (includes Thermal Oxidizer)	Btu/lb H_2O	1,600
MM (5-day basis)	mmBtu/h	25.0
AA (5-day basis)	mmBtu/h	20.0
Digester Gas Available		
MM	mmBtu/h	12.0
AA	mmBtu/h	9.6
Additional Natural Gas Purchase		
MM	mmBtu/h	13.0
AA	mmBtu/h	10.4
Odor Control		Thermal Oxidizer
Number of Storage Silos		2
Storage Volume	cy	410
Storage at AA Conditions	days	11
Storage at MM Conditions	days	7

The thickening and dewatering building for Alternative 1 (Figure 5-1 and Figure 5-2) will be expanded to accommodate the drying facility. The total evaporative capacity requirements for drying will be provided using two dryers. The use of multiple dryers allows for phased installation of the drying trains, if so desired. The dryer facility configuration is illustrated in Figure 5-4.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5.3 Alternative 4 – Incineration with Landfill Disposal of Dewatered Ash

This alternative provides incineration for raw, centrifuge dewatered solids. Figure 5-5 illustrates the fluid bed incineration process.

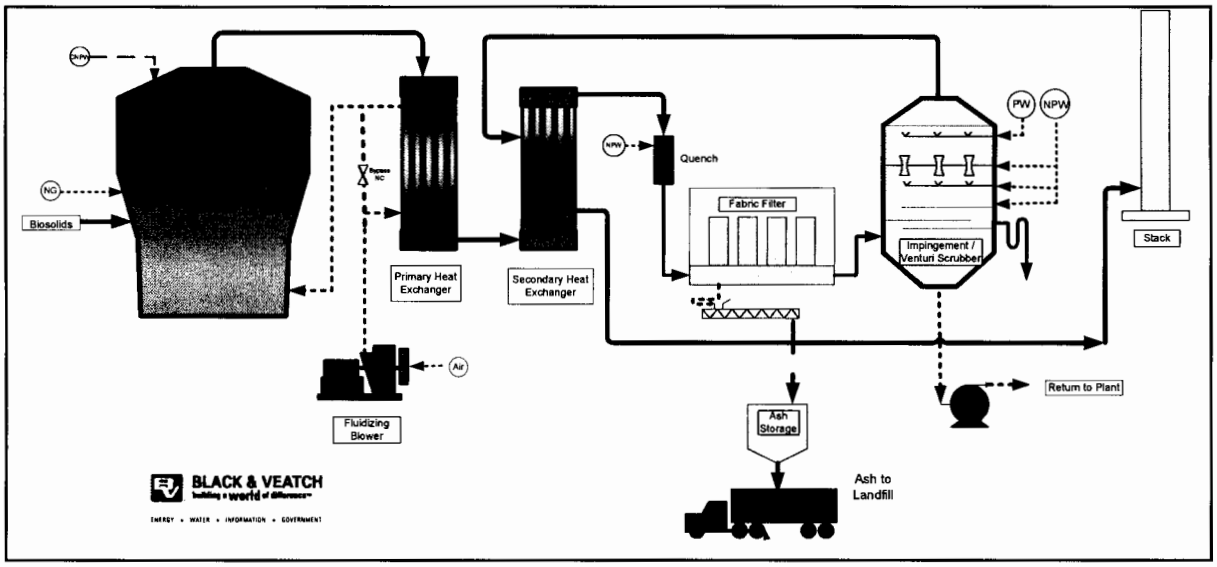


Figure 5-5. Fluid Bed Incineration System Schematic

PS and WAS thickening facilities for Alternative 4 are described in Section 4 and are identical to those for Alternative 1 and Alternative 3. The thickened PS and thickened WAS will be blended and then dewatered using new high solids centrifuges. Cake pumps will be used to transfer the dewatered solids to cake bins located in the incinerator building. The ash slurry from the incineration process will be pumped to one of two dewatering lagoons. The lagoons will be dredged periodically to remove ash at approximately 50 percent solids and hauled to the landfill for disposal.

Typical incinerator operation requires an annual shut down for 2 to 3 weeks for scheduled maintenance. Since the Pennsylvania Department of Environmental Protection (PADEP) requires the solids to be stabilized to class B standards prior to landfill disposal, a back up stabilization option is required during periods when the incinerator is out of operation. Alkaline stabilization, which meets Class B stabilization criteria, can be performed for short term periods, using temporary lime storage and feed facilities provided by a contractor. Costs for contracted alkaline stabilization during incinerator shut down are included for this alternative.

Primary sludge and WAS thickening facilities discussed under Section 4.0 – Solids Thickening are also included in this alternative. However, since the centrifuges dewater raw, rather than digested solids, the centrifuge capacity is based on different solids quantities than used for Alternatives 1 and 3 and a 24 hour, 7 day operation, rather than the 24 hour, 5 day operation used in the other alternatives. This alternative will include the following dewatering and incineration facilities.

Dewatering Facility

- 26,880 2-story thickening/dewatering building
- Three 20- inch bowl diameter dewatering centrifuges
- Centrifuge feed well, 40,000 gal with 4-hr detention
- New polymer system
- Three centrifuge feed pumps
- Two filtrate pumps
- Filtrate well, 7500 gal capacity
- Three dewatered cake pumps

Incineration Facility

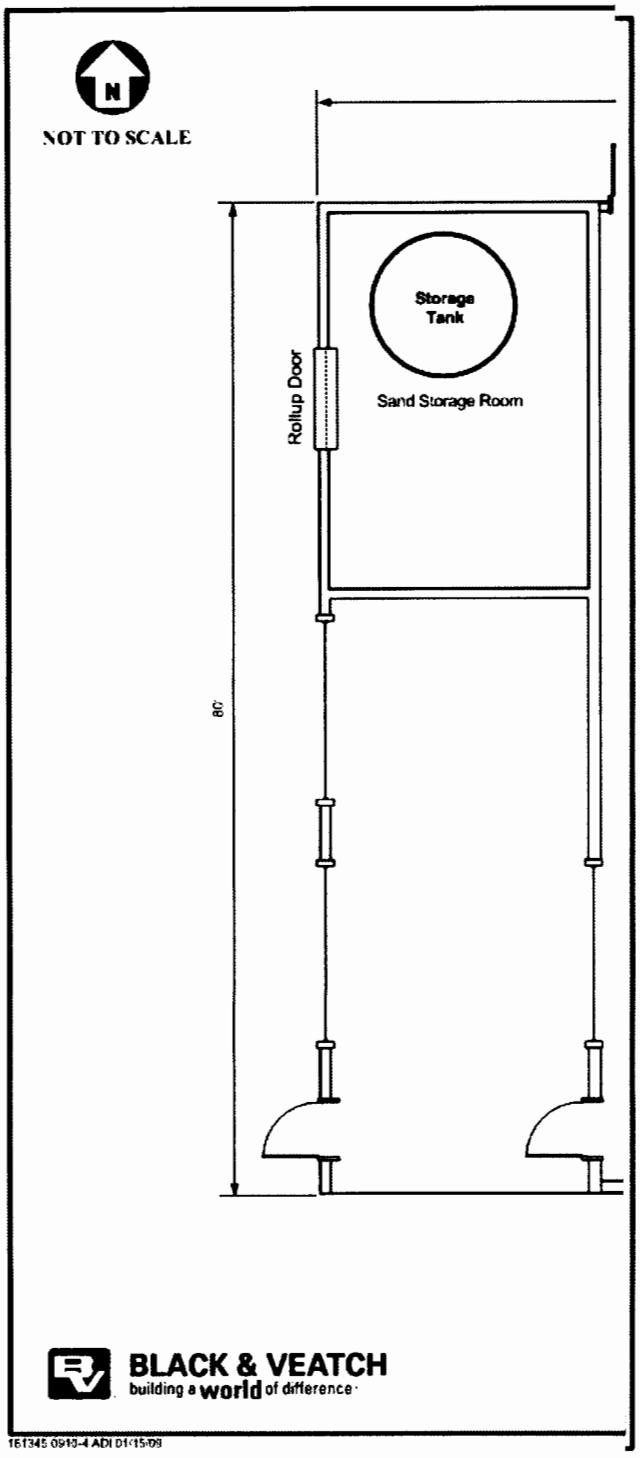
- Cake bin and piston pumps
- 22-feet diameter fluid bed incinerator
- 10,800 square feet incineration facility
- Heat recovery system
- Air pollution control system
- Sand storage silo and sand conveying system
- Ash slurry pumps
- Continuous emission monitoring system (CEMS) to monitor the emissions in the stack gas
- Two sand lined, 6,570 cubic yard ash lagoons

The conceptual design criteria for the centrifuge dewatering and incineration facilities are listed in Table 5-3.

Table 5-3. Dewatering and Incineration Design Criteria

Parameter	Units	Criteria
Centrifuge Dewatering		
Operating Schedule	h/d - d/wk	24 - 7
Number of Units		3 (2 duty, 1 spare)
Bowl Diameter	inches	20
Raw Solids (PS + WAS) - Flow		
MM (7-day basis)	gpd	250,500
AA (7-day basis)	gpd	198,000
Hydraulic Loading Rate		
MM (5-day basis)	gpm/duty machine	87
AA (5-day basis)	gpm/duty machine	69
Raw Solids (PS + WAS) - Solids		
MM	ppd	104,500
AA	ppd	82,600
Solids Loading Rate		
MM (5-day basis)	pph/machine	2,180
AA (5-day basis)	pph/machine	1,720
Polymer Dosage	lb/dt	10 - 20
Dewatered Solids	% TS	26
Incineration		
Number of Units		1
Operating Schedule	h/d - d/wk	24 - 7
Type		Fluid-Bed
Diameter	ft	22
Natural Gas Purchase (Startup only)	mmBtu/year	8,640
Total Ash Lagoon Volume	cy	8,030
Ash Storage		
MM	days	299
AA	days	365
Dewatered Ash Concentration	% TS	50
Ash		
MM	cy/d	22
AA	cy/d	18
Ash Hauling	trucks/day	2

The solids handling building will house the solids thickening and dewatering equipment identical to Alternative 1 and Alternative 3 (Figure 5-1 and Figure 5-2). The incineration facility will be located adjacent to the solids handling building. The incineration facility layout is shown in Figure 5-6.


N
NOT TO SCALE
Storage Tank
Rollup Door
Sand Storage Room
80'
BLACK & VEATCH
building a world of difference
161345 0910-4 ADI 01/15/09

Section 6. Economic Evaluation

An economic comparison of the capital and operating costs for the biosolids treatment alternatives was conducted based on the present value over a 20 year project life and an interest rate of 6 percent.

Equipment cost information for this study is taken from the Design Cost Opinion provided by B&V in 2008, where applicable. Cost information for conventional digesters is based on Technical Memorandum-6: Digestion Cost Comparison developed by B&V in November 2008. Costs that were not available from above sources are based on manufacturer's recommendations and B&V's past project experience.

6.1 Expected Opinion of Probable Costs

Construction and design factors were applied to capital costs to generate total expected opinion of probable costs. Capital costs include structures, equipment, sitework (10 percent), and electrical, instrumentation and controls costs (8 percent). Construction and design factors also include general requirements (11 percent), contingencies (30 percent), bond, insurance and fees (5 percent), and engineering and administration (10 percent).

The annual operating costs for the biosolids treatment options were developed based on average solids quantities. The annual operations and maintenance (O&M) costs include labor for operations and maintenance, utilities, equipment maintenance, chemicals, and solids hauling and disposal costs. Electric power, labor, natural gas, and polymer costs were based on typical national values. Biosolids and ash hauling and disposal costs were based on the City's current costs. The unit costs used in this evaluation are presented in Table 6-1.

Table 6-1. Unit Costs

Parameter	Unit	Cost ($)
Power	kWh	0.104
Labor (incl. benefits)	per hr	27
Polymer	per lb active polymer	2.5
Iron Salts	per lb as Fe	2.6
Landfill Disposal	per wet ton	103
Natural Gas	per mmBtu	6
Digester Cleaning	per gal	0.25
Lime Stabilization	per year	11,000

6.2 Present Worth Costs

The present worth costs used for this evaluation are developed using the expected project costs and operating costs for each alternative, based on the factors listed in Section 6.1. The present worth values are presented in 2009 dollars and correspond to an ENR index of 4782.

Lifecycle costs are based on a 20 year project life, using a 6 percent annual interest rate. Salvage values for buildings and structures are calculated based on a 50-year life, using straight line depreciation. The present worth (PW) costs represent year 2009 dollars and are presented in Table 6-2. Detailed costs for each alternative are presented in Appendix A.

Table 6-2. Summary of Biosolids Treatment Costs

Parameter	Alternative 1	Alternative 3	Alternative 4
Capital	$ 41,879,000	$ 62,611,000	$ 57,527,000
Annual O&M	$ 6,141,000	$ 3,994,000	$ 2,760,000
PW of Annual O&M	$ 70,437,000	$ 45,811,000	$ 31,657,000
Total Present Worth[1]	$ 110,558,000	$ 106,305,000	$ 87,700,000
Total Annualized PW Cost	$ 9,639,000	$ 9,268,000	$ 7,646,000

[1]Present worth costs include salvage values

Alternative 4 – Incineration with landfill disposal of dewatered ash is the low cost option based on present worth costs and Alternative 1 – Landfill of Digested and Dewatered Class B Biosolids has the highest present worth costs. The difference in lifecycle costs between Alternative 4 and the second lowest cost option, Alternative 3 - Land application of heat-dried product is 21 percent. The difference in lifecycle costs between Alternative and Alternative 3 is only 4 percent. Cost differences of less than 15 percent are not considered significant at budget level analysis.

Alternative 4 was also the lowest cost option in the 2006 evaluation. The cost differences between the 2006 and the 2009 evaluation are primarily due to the use of conventional digesters in this evaluation compared to egg-shaped digesters that were used to develop costs in 2006, the addition of new PS thickening facilities, new RDTs for WAS thickening and a new building to house the RDTs and centrifuges, which were all excluded from the 2006 study.

The O&M costs of the alternatives were not evaluated to determine their sensitivity to potential fluctuations in electric power and natural gas costs. However, Alternative 3 has greater energy requirements than Alternative 1 and Alternative 4 and would therefore be more susceptible to future energy cost increases. Alternative 1 is more sensitive to disposal costs than the other alternatives; consequently, any increases or decreases in disposal costs will impact Alternative 1 more significantly than the other alternatives.

Section 7. Non-Economic Evaluation

The non-economic evaluation conducted in 2006, which was developed based on input from City staff, was not revised as part of this study.

Based on feedback from the City, the 2006 study assigned weights to the non-economic criteria to establish the relative importance of a criterion to the City. Criterium Decision Plus (CDP) software was then used to track the non-economic criteria rankings and to arrive at an overall ranking for the alternatives.

The non-economic criteria used in evaluating the biosolids treatment alternatives and the weighting factors assigned in 2006 are presented in Table 7-1. Each biosolids treatment alternative was rated for each criterion, depending on how well it supported the criterion goal. The ratings of alternatives are presented in Table 7-2.

Table 7-1. Category and Criteria Weights (2006 Study)

Category	Category Weight	Criteria	Criteria Weight
Reliability	5	Proven Performance	5
		Simplicity	4
Impacts on Neighbors	3	Odor Potential	4
		Truck Traffic	2
		Nuisance and Aesthetics	3
		Public Acceptance	5
Implementation and O&M	4	Constructability	4
		Ease of Permitting	4
		Ease of O&M	5
		Impact of Recycle Stream	4
Sustainability	4	Capability to Meet Future Regulations	5
		Impact of Urbanization	2
		Diversity of Product Outlets	4
		Good Safety Record	5
		Green Technology	4

*Weighting factors are based on a scale of 0 to 5. Criteria weights are relative to how the criterion is weighted within its category.

Table 7-2. Alternative Ratings (2006 Study)

Category	Criteria	Alternative 1 Landfill of Class B Cake	Alternative 3 Heat Drying and Land Application	Alternative 4Incineration and Landfill of Ash
Reliability	Proven Performance	5	5	5
	Simplicity	5	5	4
Impacts on Neighbors	Odor Potential	3	4	4
	Truck Traffic	2	4	5
	Nuisance and Aesthetics	3	4	2
	Public Acceptance	4	5	1
Implementation and O&M	Constructability	4	3	5
	Ease of Permitting	5	5	2
	Ease of Operation & Maintenance	5	4	4
	Impact of Recycle Stream	3	3	4
Sustainability	Capability to Meet Future Regulations	3	5	5
	Impact of Urbanization	3	3	5
	Diversity of Product Outlets	3	5	2
	Good Safety Record	5	3	4
	Green Technology	2	5	3
	MODEL RESULTS	**4.0**	**4.1**	**3.7**

Section 8. Recommendations

Based on the results of the economic and non-economic evaluation, Alternative 1 - Landfilling of digested and dewatered Class B biosolids is still a viable biosolids management option for the City since the existing federal and state regulations do not mandate solids treatment to Class A standards. Alternative 4 - Incineration with landfill disposal of dewatered ash - has the lowest present worth cost; however, Alternative 3 has the lowest ranking among the alternatives based on the non-economic criteria. The primary concern with incineration is public perception that incinerators produce harmful air emissions. These perceptions and ensuing actions by citizens can result in increasing the time required for permitting activities.

In spite of being the most expensive option, Alternative 3 provides a viable long term biosolids management option for the City. If desired, the process modifications included under Alternative 3 can be implemented in stages to minimize capital outlay. If the project is implemented in a phased approach, modifications to the digestion facility are the recommended first step, to ensure that effective digestion is in place prior to implementing drying.

The modifications to the PS and WAS thickening processes are somewhat independent of the other systems and can therefore be implemented at any point during the project.

Appendix – Cost Data

Black & Veatch					
Owner	:	Reading, PA		Computed By	YQ
Plant	:	Fritz Island WWTP		Date	January 6, 2009
PN		161345.0910	File No.	Checked By	HS
Title	:	**Thickening, Digestion, Dewatering & Landfilling (Alt 1)**		Date	January 8, 2009
		Alt 1 - Cost Summary		Page	

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CAPITAL COST

Item Description	No. of Units		Unit Cost	2009 Cost	Salvage Value
PS Thickening - Gravity Thickener					
PS Feed Pumps	2	ea	$37,800	$76,000	
Gravity Thickener Rake Mechanism	1	LS	$300,000	$300,000	
Polymer System	1	LS	$46,000	$46,000	
Thickened PS Pumps	2	ea	$28,000	$56,000	
Decant Well	1	LS	$16,800	$17,000	
Decant Pumps	2	ea	$35,000	$70,000	
Subtotal				***$565,000***	
WAS Thickening - Rotary Drum Thickeners					
Thickening/Dewatering Building			Included under Dewatering Costs		
RDT Feed Well	1	LS	$84,000	$84,000	
RDT Feed Well Mixer	2	ea	$26,600	$53,000	
WAS Feed Pumps	3	ea	$28,700	$86,000	
Rotary Drum Thickeners	3	ea	$280,000	$840,000	
Polymer System	1	LS	$347,600	$348,000	
Thickened WAS Pumps	3	ea	$17,500	$53,000	
Filtrate Well	1	LS	$21,000	$21,000	
Filtrate Pumps	3	ea	$8,400	$25,000	
Bridge Crane	1	ea	$100,000	$100,000	
Subtotal				***$1,610,000***	
Digestion (Conventional Digesters)					
Digester Feed Tank	1	LS	$58,800	$59,000	
Digester Feed Tank Mixing Pumps	2	ea	$21,490	$43,000	
Digester Feed Pumps	3	ea	$17,500	$53,000	
Conventional Digesters	2	ea	$1,240,500	$2,481,000	$1,488,600
Primary Digester Covers - Fixed Steel	2	ea	$470,500	$941,000	
Secondary Digester	1	ea	$1,224,000	$1,224,000	
Secondary Digester Cover - Membrane Gas Holder	1	ea	$540,400	$540,000	
Digestion Equipment (Mixing, Grinders, HEX, Boiler, etc)	1	LS	$1,880,900	$1,881,000	
Gas Handling Equipment (Gas Meters, Flame Arresters, etc)	1	LS	$32,900	$33,000	
Digestion Control Building	1	LS	$2,777,000	$2,777,000	$1,666,200
Waste Gas Flare	1	ea	$67,200	$67,000	
Day Tank - Struvite Control Chemicals	850	gallon	$10	$9,000	
Struvite Control Chemicals - Metering Pumps	3	ea	$5,000	$15,000	
Subtotal				***$10,123,000***	
Dewatering - Centrifuges					
Thickening/Dewatering Building	23,240	sqft	$214	$4,973,000	$2,983,800
Centrifuge Feed Pumps	3	ea	$30,800	$92,000	
Dewatering Centrifuges	3	ea	$665,000	$1,995,000	
Polymer System	1	LS	$424,560	$425,000	
Centrifuge Discharge Screw Conveyor	3	ea	$80,000	$240,000	
Dewatered Cake Pumps	3	ea	$168,000	$504,000	
Centrate Wetwell	1	LS	$12,400	$12,000	
Centrate Wetwell Pumps	2	ea	$12,000	$24,000	
Centrate EQ Basin	1,300,000	gallon		$218,500	
Centrate EQ Basin Mixing	2	ea	$35,000	$70,000	
Centrate EQ Basin Return Pumps	2	ea	$21,490	$43,000	
Odor Control	2	LS	$438,750	$878,000	
Monorail and Hoist	3	ea	$100,000	$300,000	
Subtotal				***$9,774,500***	
Truck Scale	1	LS	$70,000	***$70,000***	
Subtotal				***$22,143,000***	$6,138,600
Electrical (at 8%, excludes cost for digesters and digester equipment)				$1,522,000	
Sitework (at 10%, excludes cost for digesters and digester equipment)				$1,902,000	
Contingencies (at 30%)				$7,670,000	
Construction Subtotal				**$33,237,000**	
CM Services, General Conditions (at 11%)				$3,656,000	
Bonds, Insurance, Fees (at 5%)				$1,662,000	
Engineering, Legal & Administration (at 10%)				$3,324,000	
Total Project Cost				**$41,879,000**	

Black & Veatch	Owner :	Reading, PA		Computed By	YQ
	Plant :	Fritz Island WWTP		Date	January 6, 2009
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		Alt 1 - Cost Summary		Page	

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ANNUAL OPERATING COSTS

Item Description	$/per year
Power	$717,000
Labor	$379,000
Equipment Maintenance	$103,000
Primary Digester Cleaning	$32,000
Primary Digester Cover Painting	$8,000
Chemicals	$1,176,000
Natural Gas	--
Disposal	$3,726,000
Total Operating Cost	**$6,141,000**

TOTAL PRESENT WORTH COSTS

Period, years	20
Interest Rate	6
P/A, operations	11.470
P/F Salvage in 2028	(0.312)
Year 0 Capital Costs	$41,879,000
PW of Membrane Cover Replacement (Secondary Digester)	$156,000
PW of Salvage Value (Buildings)	($1,914,000)
Total PW Capital Costs (includes SV)	$40,121,000
Present Worth Cost of Annual O&M	$70,437,000
Total Present Worth Costs	***$110,558,000***
Annualized Present Worth Costs	***$9,639,000***

Black & Veatch					
	Owner	:	Reading, PA	Computed	YQ
	Plant	:	Fritz Island WWTP	Date	January 6, 2009
	PN		161345.0910 File No.	Checked	HS
	Title	:	Thickening, Digestion, Dewatering & Landfilling (Alt 1)	Date	January 8, 2009
			Alt 1 - Power Costs		

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POWER USE AND COST

THICKENING

							Unit Cost for Power (per kWh)	$0.1036
Equipment List	**No. of Units**	**Installed HP**	**Operating HP**	**Hr/Day**	**Day/Wk**	**Wk/Yr**	**kWh/Yr**	**Cost $/yr**
PS Feed Pumps	1	15	12.0	24	7	52	97,756	$10,128
PS Polymer System	1	5	4.0	24	7	52	32,585	$3,376
Thickened PS Pumps	1	15	12	24	7	52	97,756	$10,128
Decant Pumps	1	8	6.4	24	7	52	52,136	$5,401
WAS Feed Well Mixer	1	5	4.0	24	7	52	32,585	$3,376
WAS Feed Pumps	2	30	24.0	24	7	52	391,023	$40,510
RDTs	2	5	4	24	7	52	65,171	$6,752
Wash Water Booster Pumps	2	7.5	6	24	7	52	97,756	$10,128
WAS Polymer System	1	10	8	24	7	52	65,171	$6,752
TWAS Pumps	1	20	16.0	24	7	52	130,341	$13,503
Filtrate Pumps	1	7.5	6.0	24	7	52	48,878	$5,064
Subtotal							**1,111,158**	**$115,100**

ANAEROBIC DIGESTION

							Unit Cost for Power (per kWh)	$0.1036
Equipment List	**No. of Units**	**Installed HP**	**Operating HP**	**Hr/Day**	**Day/Wk**	**Wk/Yr**	**kWh/Yr**	**Cost $/yr**
Digester Feed Tank Mixing Pumps	1	7.5	6	24	7	52	48,878	$5,064
Digester Feed Pumps	2	20	16	24	7	52	260,682	$27,007
Primary Digester Mixing	2	125	100	24	7	52	1,629,264	$168,792
Secondary Tank Mixing	1	125	100	24	7	52	814,632	$84,396
Grinders	3	3	2.4	24	7	52	58,654	$6,077
Boilers	1	120	96	12	7	52	391,023	$40,510
Misc. Equipment (Pumps etc)	1	50	40	24	7	52	325,853	$33,758
Subtotal							**3,203,133**	**$365,600**

CENTRIFUGE DEWATERING

							Unit Cost for Power (per kWh)	$0.1036
Equipment List	**No. of Units**	**Installed HP**	**Operating HP**	**Hr/Day**	**Day/Wk**	**Wk/Yr**	**kWh/Yr**	**Cost $/yr**
Centrifuge Feed Pumps	2	30	24	24	5	52	279,302	$28,936
Dewatering Polymer System	1	10	8	24	5	52	46,550	$4,823
Reversing Conveyors	2	5	4	24	5	52	46,550	$4,823
Dewatered Cake Pumps	2	15	12	24	5	52	139,651	$14,468
Centrate Wetwell Pumps	2	7.5	6	24	7	52	97,756	$10,128
Centrate EQ Basin Mixing	2	7.5	6	24	7	52	97,756	$10,128
Centrate EQ Basin Return Pumps	1	7.5	6	24	7	52	48,878	$5,064
Odor Control	2	25	20	24	7	52	325,853	$33,758

Equipment List	**No. of Units**	**Operating kW/gpm**	**Total kW/ Machine**	**Hr/Day**	**Day/Wk**	**Wk/Yr**	**kWh/Yr**	**Cost $/yr**
Dewatering Centrifuges	2	0.59	96	24	5	52	1,196,201	$123,926
Subtotal							**2,278,498**	**$236,100**

TOTAL **$716,800**

Black & Veatch	Owner	Reading, PA		Computed	YQ
	Plant	Fritz Island WWTP		Date	January 6, 2009
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	Title	Thickening, Digestion, Dewatering & Landfilling (Alt 1)		Date	January 8, 2009
		Alt 1 - Labor Costs			

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LABOR USE AND COST

Unit Cost for Labor (per hour) **$27.00**

THICKENING and DEWATERING

Labor Category	Number	Hr/Shift	Shift/Day	Day/Wk	Wk/Yr	Total Hours	Cost $/yr
Maintenance	1	8	1.0	5	52	2,080	56,160
Operations	1	8	3.0	7	52	8,736	235,872
Subtotal						**10,816**	**$292,032**

ANAEROBIC DIGESTION

Labor Category	Number	Hr/Shift	Shift/Day	Day/Wk	Wk/Yr	Total Hours	Cost $/yr
Operations	1	2	3.0	7	52	2,184	58,968
Maintenance	1	4	1.0	5	52	1,040	28,080
Subtotal						**3,224**	**$87,048**

TOTAL **$379,080**

Black & Veatch					
	Owner	Reading, PA		Computed	YQ
	Plant	Fritz Island WWTP		Date	January 6, 2009
	PN	161345.0910	File No.	Checked	HS
	Title	Thickening, Digestion, Dewatering & Landfilling (Alt 1)		Date	January 8, 2009
		Alt 1 - Equipment Maintenance			

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EQUIPMENT MAINTENANCE COST

THICKENING

Equipment List	No. of Units	Equip. Cost/unit	Total Equip. Cost	Maintenance %	Cost $/yr
PS Feed Pumps	2	$27,000	54,000	2%	$1,080
Gravity Thickener Mechanism Package	1	$210,000	210,000	2%	$4,200
PS Polymer System	1	$46,000	46,000	2%	$920
Thickened PS Pumps	2	$20,000	40,000	2%	$800
Decant Pumps	2	$25,000	50,000	2%	$1,000
WAS Feed Well Mixer	2	$19,025	38,050	2%	$761
WAS Feed Pumps	3	$20,500	61,500	2%	$1,230
RDTs	3	$200,000	600,000	2%	$12,000
WAS Polymer System	1	$243,331	243,331	2%	$4,867
TWAS Pumps	2	$12,500	25,000	2%	$500
Filtrate Pumps	3	$6,000	18,000	2%	$360

Subtotal **27,718**

ANAEROBIC DIGESTION

Equipment List	No. of Units	Equip. Cost/unit	Total Equip. Cost	Maintenance %	Cost $/yr
Digester Feed Tank Mixing Pumps	2	$15,350	$30,700	2%	$614
Digester Feed Pumps	3	$12,500	$37,500	2%	$750
Digester Mixing System	3	$103,750	$311,250	2%	$6,225
Boilers	2	$123,000	$246,000	2%	$4,920
Digestion Equipment (Pumps, HEX, etc)	1	$682,500	$682,500	2%	$13,650

Subtotal **26,159**

DEWATERING

Equipment List	No. of Units	Equip. Cost/unit	Total Equip. Cost	Maintenance %	Cost $/yr
Centrifuge Feed Pumps	3	$22,000	$66,000	2%	$1,320
Dewatering Centrifuges	3	$475,000	$1,425,000	2%	$28,500
Dewatering Polymer System	1	$297,200	$297,200	2%	$5,944
Reversing Conveyors	3	$56,000	$168,000	2%	$3,360
Dewatered Cake Pumps	3	$120,000	$360,000	2%	$7,200
Centrate Wetwell Pumps	2	$9,000	$18,000	2%	$360
Centrate EQ Basin Mixing	2	$15,350	$30,700	2%	$614
Centrate EQ Basin Return Pumps	2	$15,350	$30,700	2%	$614
Truck Scale	1	$58,000	$58,000	2%	$1,160

Subtotal **49,072**

TOTAL **$102,949**

Black & Veatch	Owner	Reading, PA		Computed	YQ
	Plant	Fritz Island WWTP		Date	January 6, 2009
	PN	161345.0001	File No.	Checked	HS
	Title	Thickening, Digestion, Dewatering & Landfilling (Alt 1)		Date	January 8, 2009
		Alt 1 - Cover Replacement, Painting, Cleaning			

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MEMBRANE COVER REPLACEMENT (SECONDARY DIGESTER)

ANAEROBIC DIGESTION

Item	Replacement Cost	Installation Cost	Total Replacement	Present Value factor	Cost $/yr
Membrane Cover	$386,000	$115,800	$501,800	0.312	156,464

Subtotal **$156,464**

FIXED COVER PAINTING (PRIMARY DIGESTER)

Unit Cost (per sf) $11.53

ANAEROBIC DIGESTION

Item	Number	Cover Diameter, ft	Cover Area, sf	Total Area, sf	Cost $/15 yr
Fixed Cover	2	100	7,850	15,700	181,021

Subtotal	**$181,021**
Convert to Present Value	**$95,300**
Covert to Annual Cost for 20 year Life	**$7,800**

DIGESTER CLEANING (PRIMARY DIGESTER)

Unit Cost (per gal) $0.25

ANAEROBIC DIGESTION

Item	Number	Volume/Tank, gal	Volume for Cleaning/Tank (gal)	Total Volume, gal	Cost $/5 yr
Cleaning	2	1,915,000	383,000	766,000	191,500

Subtotal	**$191,500**
Convert to Present Value	**$389,600**
Covert to Annual Cost for 20 year Life	**$32,000**

Black & Veatch				
	Owner	Reading, PA	Computed	YQ
	Plant	Fritz Island WWTP	Date	January 6, 2009
	PN	161345.0910 File No.	Checked	HS
	Title	Thickening, Digestion, Dewatering & Landfilling (Alt 1)	Date	January 8, 2009
		Alt 1 - Chemical Costs		

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CHEMICAL USE AND COSTS

Unit Cost for Polymer (per lb)	$2.50
Unit Cost for Iron Salts (per lb)	$2.60

Chemical	Dose (lb/dt)	Solids (dtpd)	Solids (dtpy)	Chemical (ppy)	Chemical ($/lb)	Cost ($/yr)
PS Thickening	1	19.9	7,275	7,275	$2.50	$18,187
WAS Thickening	10	14.9	5,442	54,420	$2.50	$136,049
Dewatering	20	21.9	7,979	159,584	$2.50	$398,961
Iron Salts	30	21.9	7,979	239,377	$2.60	$622,379

TOTAL **$1,175,576**

Black & Veatch	Owner	Reading, PA		Computed	YQ
	Plant	Fritz Island WWTP		Date	January 6, 2009
	PN	161345.0910	File No.	Checked	HS
	Title	Thickening, Digestion, Dewatering & Landfilling (Alt 1)		Date	January 8, 2009
		Alt 1 - Disposal Costs			

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HAULING AND DISPOSAL

Unit Cost for Hauling & Disposal of Dewatered Cake: $103.00 per wt

Category	dtpd	wtpd	Day/Wk	Wk/Yr	Quantity (wtpy)	Cost ($/wt)	Cost $/yr
Dewatered Cake	21.9	99	7	52	36,170	103	3,725,491

TOTAL **$3,725,500**

Black & Veatch	Owner :	Reading, PA		Computed By	YQ
	Plant :	Fritz Island WWTP		Date	January 6, 2009
	PN	161345.0910	File No.	Checked By	HS
	Title :	**Thickening, Digestion, Dewatering & Heat Drying (Alt 3)**		Date	January 8, 2009
		Alt 3 - Cost Summary		Page	

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CAPITAL COST

Item Description	No. of Units		Unit Cost	2009 Cost	Salvage Value
PS Thickening - Gravity Thickener					
PS Feed Pumps	2	ea	$37,800	$76,000	
Gravity Thickener Rake Mechanism	1	LS	$300,000	$300,000	
Polymer System	1	LS	$46,000	$46,000	
Thickened PS Pumps	2	ea	$28,000	$56,000	
Decant Well	1	LS	$16,800	$17,000	
Decant Pumps	2	ea	$35,000	$70,000	
Subtotal				***$565,000***	
WAS Thickening - Rotary Drum Thickeners					
Thickening/Dewatering Building			Included under Dewatering Costs		
RDT Feed Well	1	LS	$84,000	$84,000	
RDT Feed Well Mixer	2	ea	$26,600	$53,000	
WAS Feed Pumps	3	ea	$28,700	$86,000	
Rotary Drum Thickeners	3	ea	$280,000	$840,000	
Polymer System	1	LS	$347,600	$348,000	
Thickened WAS Pumps	3	ea	$17,500	$53,000	
Filtrate Well	1	LS	$21,000	$21,000	
Filtrate Pumps	3	ea	$8,400	$25,000	
Bridge Crane	1	ea	$100,000	$100,000	
Subtotal				***$1,610,000***	
Digestion (Conventional Digesters)					
Digester Feed Tank	1	LS	$58,800	$59,000	
Digester Feed Tank Mixing Pumps	2	ea	$21,490	$43,000	
Digester Feed Pumps	3	ea	$17,500	$53,000	
Conventional Digesters	2	ea	$1,240,500	$2,481,000	$1,488,600
Primary Digester Covers - Fixed Steel	2	ea	$470,500	$941,000	
Secondary Digester	1	ea	$1,224,000	$1,224,000	
Secondary Digester Cover - Membrane Gas Holder	1	ea	$540,400	$540,000	
Digestion Equipment (Mixing, Grinders, HEX, Boiler, etc)	1	LS	$1,880,900	$1,881,000	
Gas Handling Equipment (Gas Meters, Flame Arresters, etc)	1	LS	$32,900	$33,000	
Digestion Control Building	1	LS	$2,777,000	$2,777,000	$1,666,200
Waste Gas Flare	1	ea	$67,200	$67,000	
Day Tank - Struvite Control Chemicals	850	gallon	$10	$9,000	
Struvite Control Chemicals - Metering Pumps	3	ea	$5,000	$15,000	
Subtotal				***$10,123,000***	
Dewatering - Centrifuges					
Thickening/Dewatering Building	23,240	sqft	$214	$4,973,000	$2,983,800
Centrifuge Feed Pumps	3	ea	$30,800	$92,000	
Dewatering Centrifuges	3	ea	$665,000	$1,995,000	
Polymer System	1	LS	$424,560	$425,000	
Centrifuge Discharge Screw Conveyor	3	ea	$80,000	$240,000	
Dewatered Cake Pumps	3	ea	$168,000	$504,000	
Centrate Wetwell	1	LS	$12,400	$12,000	
Centrate Wetwell Pumps	2	ea	$12,000	$24,000	
Centrate EQ Basin	1,300,000	gallon		$218,500	
Centrate EQ Basin Mixing	2	ea	$35,000	$70,000	
Centrate EQ Basin Return Pumps	2	ea	$21,490	$43,000	
Odor Control	2	LS	$438,750	$878,000	
Monorail and Hoist	3	ea	$100,000	$300,000	
Subtotal				***$9,774,500***	

Black & Veatch					
	Owner :	Reading, PA		Computed By	YQ
	Plant :	Fritz Island WWTP		Date	January 6, 2009
	PN	161345.0910	File No.	Checked By	HS
	Title :	**Thickening, Digestion, Dewatering & Heat Drying (Alt 3)**		Date	January 8, 2009
		Alt 3 - Cost Summary		Page	

DO NOT WRITE IN THIS SPACE

CAPITAL COST

Item Description	No. of Units		Unit Cost	2009 Cost	Salvage Value
Thermal Drying					
Drying Building	8,960	sqft	$214	$1,917,000	$1,150,200
Biosolids Drying Equipment	1	LS	$8,528,000	$8,528,000	
Subtotal				***$10,445,000***	
Truck Scale	1	LS	$70,000	***$70,000***	
Subtotal				***$32,588,000***	$7,288,800
Electrical (at 8%, excludes cost for digesters and digester equipment)				$2,505,000	
Sitework (at 10%, excludes cost for digesters and digester equipment)				$3,131,000	
Contingencies (at 30%)				$11,467,000	
Construction Subtotal				**$49,691,000**	
CM Services, General Conditions (at 11%)				$5,466,000	
Bonds, Insurance, Fees (at 5%)				$2,485,000	
Engineering, Legal & Administration (at 10%)				$4,969,000	
Total Project Cost				**$62,611,000**	

ANNUAL OPERATING COSTS

Item Description	$/per year
Power	$903,000
Labor	$604,000
Equipment Maintenance	$234,000
Primary Digester Cleaning	$32,000
Primary Digester Cover Painting	$8,000
Chemicals	$1,176,000
Natural Gas	$894,000
Landfill Disposal of Cake (2 weeks/year)	$143,000
Total Operating Cost	**$3,994,000**

TOTAL PRESENT WORTH COSTS

Period, years	20
Interest Rate	6
P/A, operations	11.470
P/F Salvage in 2028	(0.312)
Year 0 Capital Costs	$62,611,000
PW of Salvage Value (Buildings)	($2,273,000)
PW of Membrane Cover Replacement (Secondary Digester)	$156,000
Total PW Capital Costs (includes SV)	$60,494,000
Present Worth Cost of Annual O&M	$45,811,000
Total Present Worth Costs	***$106,305,000***
Annualized Present Worth Costs	***$9,268,000***

Black & Veatch					
	Owner	:	Reading, PA	Computed	YQ
	Plant	:	Fritz Island WWTP	Date	January 6, 2009
	PN		161345.0910 File No.	Checked	HS
	Title	:	Thickening, Digestion, Dewatering & Heat Drying (Alt 3)	Date	January 8, 2009
			Alt 3 - Power Costs		

DO NOT WRITE IN THIS SPACE

POWER USE AND COST

THICKENING

						Unit Cost for Power (per kWh)		$0.104
Equipment List	**No. of Units**	**Installed HP**	**Operating HP**	**Hr/Day**	**Day/Wk**	**Wk/Yr**	**kWh/Yr**	**Cost $/yr**
PS Feed Pumps	1	15	12.0	24	7	52	97,756	$10,128
PS Polymer System	1	5	4.0	24	7	52	32,585	$3,376
Thickened PS Pumps	1	15	12	24	7	52	97,756	$10,128
Decant Pumps	1	8	6.4	24	7	52	52,136	$5,401
WAS Feed Well Mixer	1	5	4.0	24	7	52	32,585	$3,376
WAS Feed Pumps	2	30	24.0	24	7	52	391,023	$40,510
RDTs	2	5	4	24	7	52	65,171	$6,752
Wash Water Booster Pumps	2	7.5	6	24	7	52	97,756	$10,128
WAS Polymer System	1	10	8	24	7	52	65,171	$6,752
TWAS Pumps	1	20	16.0	24	7	52	130,341	$13,503
Filtrate Pumps	1	7.5	6.0	24	7	52	48,878	$5,064
Subtotal							**1,111,158**	**$115,100**

ANAEROBIC DIGESTION

						Unit Cost for Power (per kWh)		$0.104
Equipment List	**No. of Units**	**Installed HP**	**Operating HP**	**Hr/Day**	**Day/Wk**	**Wk/Yr**	**kWh/Yr**	**Cost $/yr**
Digester Feed Tank Mixing Pumps	1	7.5	6	24	7	52	48,878	$5,064
Digester Feed Pumps	2	20	16	24	7	52	260,682	$27,007
Primary Digester Mixing	2	125	100	24	7	52	1,629,264	$168,792
Secondary Tank Mixing	1	125	100	24	7	52	814,632	$84,396
Grinders	3	3	2.4	24	7	52	58,654	$6,077
Boilers	1	120	96	12	7	52	391,023	$40,510
Misc. Equipment (Pumps etc)	1	50	40	24	7	52	325,853	$33,758
Subtotal							**3,528,986**	**$365,600**

CENTRIFUGE DEWATERING

						Unit Cost for Power (per kWh)		$0.104
Equipment List	**No. of Units**	**Installed HP**	**Operating HP**	**Hr/Day**	**Day/Wk**	**Wk/Yr**	**kWh/Yr**	**Cost $/yr**
Centrifuge Feed Pumps	2	30	24	24	5	52	279,302	$28,936
Dewatering Polymer System	1	10	8	24	5	52	46,550	$4,823
Reversing Conveyors	2	5	4	24	5	52	46,550	$4,823
Dewatered Cake Pumps	2	15	12	24	5	52	139,651	$14,468
Centrate Wetwell Pumps	2	7.5	6	24	7	52	97,756	$10,128
Centrate EQ Basin Mixing	2	7.5	6	24	7	52	97,756	$10,128
Centrate EQ Basin Return Pumps	1	7.5	6	24	7	52	48,878	$5,064
Odor Control	2	25	20	24	7	52	325,853	$33,758

Equipment List	**No. of Units**	**Operating kW/gpm**	**Total kW/ Machine**	**Hr/Day**	**Day/Wk**	**Wk/Yr**	**kWh/Yr**	**Cost $/yr**
Dewatering Centrifuges	2	0.59	96	24	5	52	1,196,201	$123,926
Subtotal							**2,278,498**	**$236,100**

Black & Veatch	Owner	:	Reading, PA	Computed	YQ
	Plant	:	Fritz Island WWTP	Date	January 6, 2009
	PN		161345.0910 File No.	Checked	HS
	Title	:	Thickening, Digestion, Dewatering & Heat Drying (Alt 3)	Date	January 8, 2009
			Alt 3 - Power Costs		

DO NOT WRITE IN THIS SPACE

THERMAL DRYING

							Unit Cost for Power (per kWh)	$0.104
Equipment List	**No. of Units**	**Installed HP**	**Operating HP**	**Hr/Day**	**Day/Wk**	**Wk/Yr**	**kWh/Yr**	**Cost $/yr**
Dryer Feed Pumps	2	30	24	24	5	50	268,560	$27,823
Dryer Paddle Motor	1	200	160	24	5	50	895,200	$92,743
Dryer Discharge Conveyors	2	5	4	24	5	50	44,760	$4,637
Dry Product Cooler Motors	4	5	4	24	5	50	89,520	$9,274
Vibroscreens Motors	2	0.75	0.6	24	5	50	6,714	$696
Fines Return Conveyor Motors	2	2	1.6	24	5	50	17,904	$1,855
Air Compressor Motors	2	50	40	24	5	50	447,600	$46,371
Air Compressor Cooling Motors	2	3	2.4	24	5	50	26,856	$2,782
Subtotal							**1,797,114**	**$186,200**

TOTAL **$903,000**

Black & Veatch	Owner	Reading, PA		Computed	YQ
	Plant	Fritz Island WWTP		Date	January 6, 2009
	PN	161345.0001	File No.	Checked	HS
	Title	Thickening, Digestion, Dewatering & Heat Drying (Alt 3)		Date	January 8, 2009
		Alt 3 - Labor Costs			

DO NOT WRITE IN THIS SPACE

LABOR USE AND COST

Unit Cost for Labor (per hour) $27.00

THICKENING and DEWATERING

Labor Category	Number	Hr/Shift	Shift/Day	Day/Wk	Wk/Yr	Total Hours	Cost $/yr
Maintenance	1	8	1.0	5	52	2,080	56,160
Operations	1	8	3.0	7	52	8,736	235,872
Subtotal						**10,816**	**$292,032**

ANAEROBIC DIGESTION

Labor Category	Number	Hr/Shift	Shift/Day	Day/Wk	Wk/Yr	Total Hours	Cost $/yr
Operations	1	2	3.0	7	52	2,184	58,968
Maintenance	1	4	1.0	5	52	1,040	28,080
Subtotal						**3,224**	**$87,048**

THERMAL DRYING

Labor Category	Number	Hr/Shift	Shift/Day	Day/Wk	Wk/Yr	Total Hours	Cost $/yr
Operations	1	8	3.0	5	52	6,240	168,480
Maintenance	1	8	1.0	5	52	2,080	56,160
Subtotal						**8,320**	**$224,640**

TOTAL **$603,720**

Black & Veatch				
Owner	Reading, PA		Computed	YQ
Plant	Fritz Island WWTP		Date	January 6, 2009
PN	161345.0910	File No.	Checked	HS
Title	Thickening, Digestion, Dewatering & Heat Drying (Alt 3)		Date	January 8, 2009
	Alt 3 - Equipment Maintenance			

DO NOT WRITE IN THIS SPACE

EQUIPMENT MAINTENANCE COST

THICKENING

Equipment List	No. of Units	Equip. Cost/unit	Total Equip. Cost	Maintenance %	Cost $/yr
PS Feed Pumps	2	$27,000	54,000	2%	$1,080
Gravity Thickener Mechanism Package	1	$210,000	210,000	2%	$4,200
PS Polymer System	1	$46,000	46,000	2%	$920
Thickened PS Pumps	2	$20,000	40,000	2%	$800
Decant Pumps	2	$25,000	50,000	2%	$1,000
WAS Feed Well Mixer	2	$19,025	38,050	2%	$761
WAS Feed Pumps	3	$20,500	61,500	2%	$1,230
RDTs	3	$200,000	600,000	2%	$12,000
WAS Polymer System	1	$243,331	243,331	2%	$4,867
TWAS Pumps	2	$12,500	25,000	2%	$500
Filtrate Pumps	3	$6,000	18,000	2%	$360

Subtotal **27,718**

ANAEROBIC DIGESTION

Equipment List	No. of Units	Equip. Cost/unit	Total Equip. Cost	Maintenance %	Cost $/yr
Digester Feed Tank Mixing Pumps	2	$15,350	$30,700	2%	$614
Digester Feed Pumps	3	$12,500	$37,500	2%	$750
Digester Mixing System	3	$103,750	$311,250	2%	$6,225
Boilers	2	$123,000	$246,000	2%	$4,920
Digestion Equipment (Pumps, HEX, etc)	1	$682,500	$682,500	2%	$13,650

Subtotal **26,159**

DEWATERING

Equipment List	No. of Units	Equip. Cost/unit	Total Equip. Cost	Maintenance %	Cost $/yr
Centrifuge Feed Pumps	3	$22,000	$66,000	2%	$1,320
Dewatering Centrifuges	3	$475,000	$1,425,000	2%	$28,500
Dewatering Polymer System	1	$297,200	$297,200	2%	$5,944
Reversing Conveyors	3	$56,000	$168,000	2%	$3,360
Dewatered Cake Pumps	3	$120,000	$360,000	2%	$7,200
Centrate Wetwell Pumps	2	$9,000	$18,000	2%	$360
Centrate EQ Basin Mixing	2	$15,350	$30,700	2%	$614
Centrate EQ Basin Return Pumps	2	$15,350	$30,700	2%	$614
Truck Scale	1	$58,000	$58,000	2%	$1,160

Subtotal **49,072**

THERMAL DRYING

Equipment List	No. of Units	Equip. Cost/unit	Total Equip. Cost	Maintenance %	Cost $/yr
Biosolids Drying Equipment	2	$3,280,000	$6,560,000	2%	$131,200

Subtotal **131,200**

TOTAL **$234,149**

Black & Veatch	Owner	Reading, PA		Computed	YQ
	Plant	Fritz Island WWTP		Date	January 6, 2009
	PN	161345.0001	File No.	Checked	HS
	Title	Thickening, Digestion, Dewatering & Heat Drying (Alt 3)		Date	January 8, 2009
		Alt 3 - Cover Replacement, Painting, Cleaning			

DO NOT WRITE IN THIS SPACE

MEMBRANE COVER REPLACEMENT (SECONDARY DIGESTER)

ANAEROBIC DIGESTION

Item	Replacement Cost	Installation Cost	Total Replacement	Present Value factor	Cost $/yr
Membrane Cover	$386,000	$115,800	$501,800	0.312	156,464

Subtotal **$156,464**

FIXED COVER PAINTING (PRIMARY DIGESTER)

Unit Cost (per sf) **$11.53**

ANAEROBIC DIGESTION

Item	Number	Cover Diameter, ft	Cover Area, sf	Total Area, sf	Cost $/15 yr
Fixed Cover	2	100	7,850	15,700	181,021

Subtotal	**$181,021**
Convert to Present Value	**$95,300**
Covert to Annual Cost for 20 year Life	**$7,800**

DIGESTER CLEANING (PRIMARY DIGESTER)

Unit Cost (per gal) **$0.25**

ANAEROBIC DIGESTION

Item	Number	Volume/Tank, gal	Volume for Cleaning/Tank (gal)	Total Volume, gal	Cost $/5 yr
Cleaning	2	1,915,000	383,000	766,000	191,500

Subtotal	**$191,500**
Convert to Present Value	**$389,600**
Covert to Annual Cost for 20 year Life	**$32,000**

Black & Veatch					
	Owner	Reading, PA		Computed	YQ
	Plant	Fritz Island WWTP		Date	January 6, 2009
	PN	161345.0910	File No.	Checked	HS
	Title	Thickening, Digestion, Dewatering & Heat Drying (Alt 3)		Date	January 8, 2009
		Alt 3 - Chemical Costs			

DO NOT WRITE IN THIS SPACE

CHEMICAL USE AND COSTS

Unit Cost for Polymer (per lb)	$2.50
Unit Cost for Iron Salts (per lb)	$2.60

Chemical	Dose (lb/dt)	Solids (dtpd)	Solids (dtpy)	Chemical (ppy)	Chemical ($/lb)	Cost ($/yr)
PS Thickening	1	19.9	7,275	7,275	$2.50	$18,187
WAS Thickening	10	14.9	5,442	54,420	$2.50	$136,049
Dewatering	20	21.9	7,979	159,584	$2.50	$398,961
Iron Salts	30	21.9	7,979	239,377	$2.60	$622,379

TOTAL **$1,175,576**

Black & Veatch	Owner	Reading, PA		Computed	YQ
	Plant	Fritz Island WWTP		Date	January 6, 2009
	PN	161345.0910	File No.	Checked	HS
	Title	Thickening, Digestion, Dewatering & Heat Drying (Alt 3)		Date	January 8, 2009
		Alt 3 - Natural Gas Costs			

DO NOT WRITE IN THIS SPACE

NATURAL GAS USE AND COSTS

Natural Gas Cost ($/mmBtu) $13.23

Equipment	Use (mmBtu/hr)	Hr/Day	Day/Wk	Wk/Yr	Unit Price ($/mmBtu)	Use (mmBtu/yr)	Cost ($/yr)
Thermal Drying	11.3	24	5	50	13.23	67,537	893,512

TOTAL **$894,000**

Black & Veatch	Owner	Reading, PA		Computed	YQ
	Plant	Fritz Island WWTP		Date	January 6, 2009
	PN	161345.0910	File No.	Checked	HS
	Title	Thickening, Digestion, Dewatering & Heat Drying (Alt 3)		Date	January 8, 2009
		Alt 3 - Disposal Costs			

DO NOT WRITE IN THIS SPACE

HAULING AND DISPOSAL

Unit Cost for Hauling & Disposal of Dried Product	$0.00	per wt
Unit Cost for Hauling & Disposal of Dewatered Cake	$103.00	

Category	dtpd	wtpd	Day/Wk	Wk/Yr	Quantity (wtpy)	Cost ($/wt)	Cost $/yr
Dewatered Cake	21.9	99	7	2	1,391	103	143,288
Dried Product	21.9	24	7	50	8,317	0	0

TOTAL **$143,300**

Black & Veatch						
	Owner	:	Reading, PA		Computed By	DY
	Plant	:	Fritz Island WWTP		Date	December 22, 2008
	PN		161345.0910	File No.	Checked By	HS
	Title	:	Thickening, Dewatering & Incineration		Date	January 6, 2009
			Alt 4 - Cost Summary			

DO NOT WRITE IN THIS SPACE

CAPITAL COST

Item Description	No. of Units		Unit Cost	2009 Cost	Salvage Value
PS Thickening - Gravity Thickener					
PS Feed Pumps	2	ea	$37,800	$76,000	
Gravity Thickener Rake Mechanism	1	LS	$300,000	$300,000	
Polymer System	1	LS	$46,000	$46,000	
Thickened PS Pumps	2	ea	$28,000	$56,000	
Decant Well	1	LS	$16,800	$17,000	
Decant Pumps	2	ea	$35,000	$70,000	
Subtotal				***$565,000***	
WAS Thickening - Rotary Drum Thickeners					
Thickening/Dewatering Building			Included under Dewatering Costs		
RDT Feed Well	1	LS	$84,000	$84,000	
RDT Feed Well Mixer	2	ea	$26,600	$53,000	
WAS Feed Pumps	3	ea	$28,700	$86,000	
Rotary Drum Thickeners	3	ea	$280,000	$840,000	
Polymer System	1	LS	$347,600	$348,000	
Thickened WAS Pumps	3	ea	$17,500	$53,000	
Filtrate Well	1	LS	$21,000	$21,000	
Filtrate Pumps	3	ea	$8,400	$25,000	
Bridge Crane	1	ea	$100,000	$100,000	
Subtotal				***$1,610,000***	
Dewatering - Centrifuges					
Thickening/Dewatering Building	23,240	sqft	$214	$4,973,000	$2,983,800
Centrifuge Feed Well Mixer	2	ea	$21,500	$43,000	
Centrifuge Feed Well	1	ea	$56,000	$56,000	
Centrifuge Feed Pumps	3	ea	$44,100	$132,000	
Dewatering Centrifuges	3	ea	$770,000	$2,310,000	
Grinders	3	ea	$47,600	$143,000	
Polymer System	1	LS	$424,560	$425,000	
Reversing Screw Conveyors	40	lin. ft.	$2,800	$112,000	
Cake Pumps	3	ea	$120,400	$361,000	
Cake Piping	630	lin. ft.	$120	$76,000	
Centrate Pumps	2	ea	$18,900	$38,000	
Centrate Well	1	LS	$10,500	$11,000	
Odor Control	2	LS	$438,750	$878,000	
Monorail and Hoist	3	ea	$100,000	$300,000	
Subtotal				***$9,858,000***	
Truck Scale	1	LS	$70,000	***$70,000***	
Incineration Facility					
Incinerator Building	10,800	sqft	$274	$2,959,000	$1,775,400
Ash Pond Excavation, Bedding, and Lining	1	LS	$975,645	$976,000	
Incineration Equipment	1	each	$12,300,000	$12,300,000	
Heat Recovery Equipment	1	LS	$400,000	$400,000	
Emission Testing	1	each	$50,000	$50,000	
Startup and Commisioning	1	each	$75,000	$75,000	
Sand Bins	1	each	$200,000	$200,000	
Cake Bin and Piston Pumps	1	LS	$700,000	$700,000	
Subtotal				***$17,660,000***	
Subtotal				***$29,763,000***	
Electrical (at 8%)				$2,381,000	
Sitework (at 10%)				$2,976,000	
Contingencies (at 30%)				$10,536,000	
Construction Subtotal				***$45,656,000***	
CM Services, General Conditions (at 11%)				$5,022,000	
Bonds, Insurance, Fees (at 5%)				$2,283,000	
Engineering, Legal & Administration (at 10%)				$4,566,000	
Total Project Cost				**$57,527,000**	

Black & Veatch	Owner	:	Reading, PA			Computed By	DY
	Plant	:	Fritz Island WWTP			Date	December 22, 2008
	PN		161345.0910	File No.		Checked By	HS
	Title	:	Thickening, Dewatering & Incineration			Date	January 6, 2009
			Alt 4 - Cost Summary				

DO NOT WRITE IN THIS SPACE

ANNUAL OPERATING COSTS

Item Description	$/per year
Power	$694,000
Labor	$584,000
Chemicals	$631,000
Equipment Maintenance	$311,000
Lime Stabilization	$11,000
Ash Disposal	$415,000
Natural Gas	$114,000
Total Operating Cost	**$2,760,000**

TOTAL PRESENT WORTH COSTS

Period, years	20
Interest Rate	6
P/A, operations	11.470
P/F Salvage in 2028	(0.312)
Year 0 Capital Costs	57,527,000
PW of Salvage Value (Buildings)	(1,483,941)
Total PW Capital Costs (includes SV)	56,043,059
Present Worth Cost of Annual O&M	31,657,000
Total Present Worth Costs	**87,700,000**
Annualized Present Worth Costs	***7,646,000***

Black & Veatch	Owner	:	Reading, PA		Computed	DY
	Plant	:	Fritz Island WWTP		Date	December 22, 2008
	PN		161345.0910	File No.	Checked	HS
	Title	:	Thickening, Dewatering & Incineration		Date	January 6, 2009
			Alt 4 - Power Costs			

DO NOT WRITE IN THIS SPACE

POWER USE AND COST

THICKENING

							Unit Cost for Power (per kWh)	$0.104
Equipment List	**No. of Units**	**Installed HP**	**Operating HP**	**Hr/Day**	**Day/Wk**	**Wk/Yr**	**kWh/Yr**	**Cost $/yr**
PS Feed Pumps	1	15	12.0	24	7	52	97,756	$10,128
PS Polymer System	1	5	4.0	24	7	52	32,585	$3,376
Thickened PS Pumps	1	15	12	24	7	52	97,756	$10,128
Decant Pumps	1	8	6.4	24	7	52	52,136	$5,401
WAS Feed Well Mixer	1	5	4.0	24	7	52	32,585	$3,376
WAS Feed Pumps	2	30	24.0	24	7	52	391,023	$40,510
RDTs	2	5	4	24	7	52	65,171	$6,752
Wash Water Booster Pumps	2	7.5	6	24	7	52	97,756	$10,128
WAS Polymer System	1	10	8	24	7	52	65,171	$6,752
TWAS Pumps	1	20	16.0	24	7	52	130,341	$13,503
Filtrate Pumps	1	7.5	6.0	24	7	52	48,878	$5,064
Subtotal							**1,111,158**	**$115,100**

DEWATERING

							Unit Cost for Power (per kWh)	$0.104
Equipment List	**No. of Units**	**Installed HP**	**Operating HP**	**Hr/Day**	**Day/Wk**	**Wk/Yr**	**kWh/Yr**	**Cost $/yr**
Centrifuge feed tank mixing	2	7.5	6.0	24	7	52	97,756	$10,128
Centrifuge feed pumps	2	20	16.0	24	7	52	260,682	$27,007
Polymer system	1	10	8.0	24	7	52	65,171	$6,752
Reversing conveyors	2	5	4.0	24	7	52	65,171	$6,752
Cake pumps	2	15	12.0	24	7	52	195,512	$20,255
Grinders	2	2.4	1.9	24	7	52	31,282	$3,241
Centrate pumps	1	7.5	6	24	7	52	48,878	$5,064
Odor Control	2	25	20	24	7	52	325,853	$33,758

Equipment List	**No. of Units**	**Operating kW**	**Total kW/ Machine**	**Hr/Day**	**Day/Wk**	**Wk/Yr**	**kWh/Yr**	**Cost $/yr**
Centrifuges	2	0.59	34.2	24	7	52	747,626	$77,454
Subtotal							**1,837,929**	**$190,400**

INCINERATION

							Unit Cost for Power (per kWh)	$0.104
Equipment List	**No. of Units**	**Installed HP**	**Operating HP**	**Hr/Day**	**Day/Wk**	**Wk/Yr**	**kWh/Yr**	**Cost $/yr**
Incinerator	1		278.7	24	7	50	2,183,214	$226,181
Receiving Station & Pumps	1		200.0	24	7	50	1,566,600	$162,300
Subtotal							**3,749,814**	**$388,500**

TOTAL **$694,000**

Black & Veatch					
	Owner	Reading, PA	Computed	DY
	Plant	Fritz Island WWTP	Date	December 22, 2008
	PN	161345.0001 File No.	Checked	HS
	Title	Thickening, Dewatering & Incineration	Date	January 6, 2009
		Alt 4 - Labor Costs		

DO NOT WRITE IN THIS SPACE

LABOR USE AND COST

Unit Cost for Labor (per hour) $27.00

THICKENING and DEWATERING

Labor Category	Number	Hr/Shift	Shift/Day	Day/Wk	Wk/Yr	Total Hours	Cost $/yr
Maintenance	1	8	1.0	5	52	2,080	56,160
Operations	1	8	3.0	7	52	8,736	235,872
Subtotal						**10,816**	**$292,032**

INCINERATION

Labor Category	Number	Hr/Shift	Shift/Day	Day/Wk	Wk/Yr	Total Hours	Cost $/yr
Operations	1	8	3.0	7	52	8,736	235,872
Maintenance	1	8	1.0	5	52	2,080	56,160
Subtotal						**10,816**	**$292,032**

TOTAL **$584,064**

Black & Veatch					
Owner	Reading, PA			Computed	DY
Plant	Fritz Island WWTP			Date	December 22, 2008
PN	161345.0910	File No.		Checked	HS
Title	Thickening, Dewatering & Incineration			Date	January 6, 2009
	Alt 4 - Equipment Maintenance				

DO NOT WRITE IN THIS SPACE

EQUIPMENT MAINTENANCE COST

THICKENING

Equipment List	No. of Units	Equip. Cost/unit	Total Equip. Cost	Maintenance %	Cost $/yr
PS Feed Pumps	2	$27,000	54,000	2%	$1,080
Gravity Thickener Mechanism Package	1	$210,000	210,000	2%	$4,200
PS Polymer System	1	$46,000	46,000	2%	$920
Thickened PS Pumps	2	$20,000	40,000	2%	$800
Decant Pumps	2	$25,000	50,000	2%	$1,000
WAS Feed Well Mixer	2	$19,025	38,050	2%	$761
WAS Feed Pumps	3	$20,500	61,500	2%	$1,230
RDTs	3	$200,000	600,000	2%	$12,000
WAS Polymer System	1	$243,331	243,331	2%	$4,867
TWAS Pumps	3	$12,500	37,500	2%	$750
Filtrate Pumps	3	$6,000	18,000	2%	$360
Subtotal					**27,968**

DEWATERING

Equipment List	No. of Units	Equip. Cost/unit	Total Equip. Cost	Maintenance %	Cost $/yr
Centrifuge feed tank mixing	2	$15,350	30,700	2%	$614
Centrifuge feed pumps	3	$31,529	94,587	2%	$1,892
Polymer system	1	$297,192	297,192	2%	$5,944
Reversing conveyors	3	$80,000	240,000	2%	$4,800
Cake pumps	3	$86,000	258,000	2%	$5,160
Centrate pumps	2	$13,465	26,930	2%	$539
Grinders	3	$34,000	102,000	2%	$2,040
Centrifuges	3	$550,000	1,650,000	2%	$33,000
Truck Scale	1	$58,000	$58,000	2%	$1,160
Subtotal					**55,148**

INCINERATION

Equipment List	No. of Units	Cost/Unit	Total Equip. Cost	Maintenance %	Cost $/yr
Incinerator	1	$10,300,000	10,300,000	2%	$206,000
Heat Recovery Equipment	1	$400,000	400,000	2%	$8,000
Receiving Station & Pumps	1	$700,000	700,000	2%	$14,000
Subtotal					**228,000**

TOTAL **$311,116**

Black & Veatch					
	Owner	Reading, PA		Computed	DY
	Plant	Fritz Island WWTP		Date	December 22, 2008
	PN	161345.0910	File No.	Checked	HS
	Title	Thickening, Dewatering & Incineration		Date	January 6, 2009
		Alt 4 - Chemical Costs			

DO NOT WRITE IN THIS SPACE

CHEMICAL USE AND COSTS

Unit Cost for Polymer (per lb) $2.50

Chemical	Dose (lb/dt)	Solids (dtpd)	Solids (dtpy)	Chemical (ppy)	Chemical ($/lb)	Cost ($/yr)
PS Thickening	1	19.9	7,275	7,275	$2.50	$18,187
WAS Thickening	10	14.9	5,442	54,420	$2.50	$136,049
Dewatering	15	34.8	12,717	190,749	$2.50	$476,873

TOTAL **$631,108**

Black & Veatch					
	Owner	Reading, PA		Computed	DY
	Plant	Fritz Island WWTP		Date	December 22, 2008
	PN	161345.0910	File No.	Checked	HS
	Title	Thickening, Dewatering & Incineration		Date	January 6, 2009
		Alt 4 - Natural Gas Costs			

DO NOT WRITE IN THIS SPACE

NATURAL GAS USE AND COSTS

Natural Gas Cost ($/mmBtu) **$13.23**

Equipment	Use (mmBtu/hr)	Hr/Day	Day/Wk	Wk/Yr	Unit Price ($/mmBtu)	Use (mmBtu/yr)	Cost ($/yr)
Incineration	20.0	24	3	6	13.23	8,640	114,307

TOTAL **$114,000**

Black & Veatch	Owner	:	Reading, PA	Computed	DY
	Plant	:	Fritz Island WWTP	Date	December 22, 2008
	PN		161345.0910 File No.	Checked	HS
	Title	:	Thickening, Dewatering & Incineration	Date	January 6, 2009
			Alt 4 - Disposal Costs		

DO NOT WRITE IN THIS SPACE

HAULING AND DISPOSAL

Unit Cost for Hauling & Disposal (Dewatered Cake) **$103.00** per wt

Category	dtpd	wtpd	Day/Wk	Wk/Yr	Quantity (wtpy)	Cost ($/wt)	Cost $/yr
Incinerator Ash	5.8	12	7	50	4,026	103	414,649

TOTAL **$414,600**